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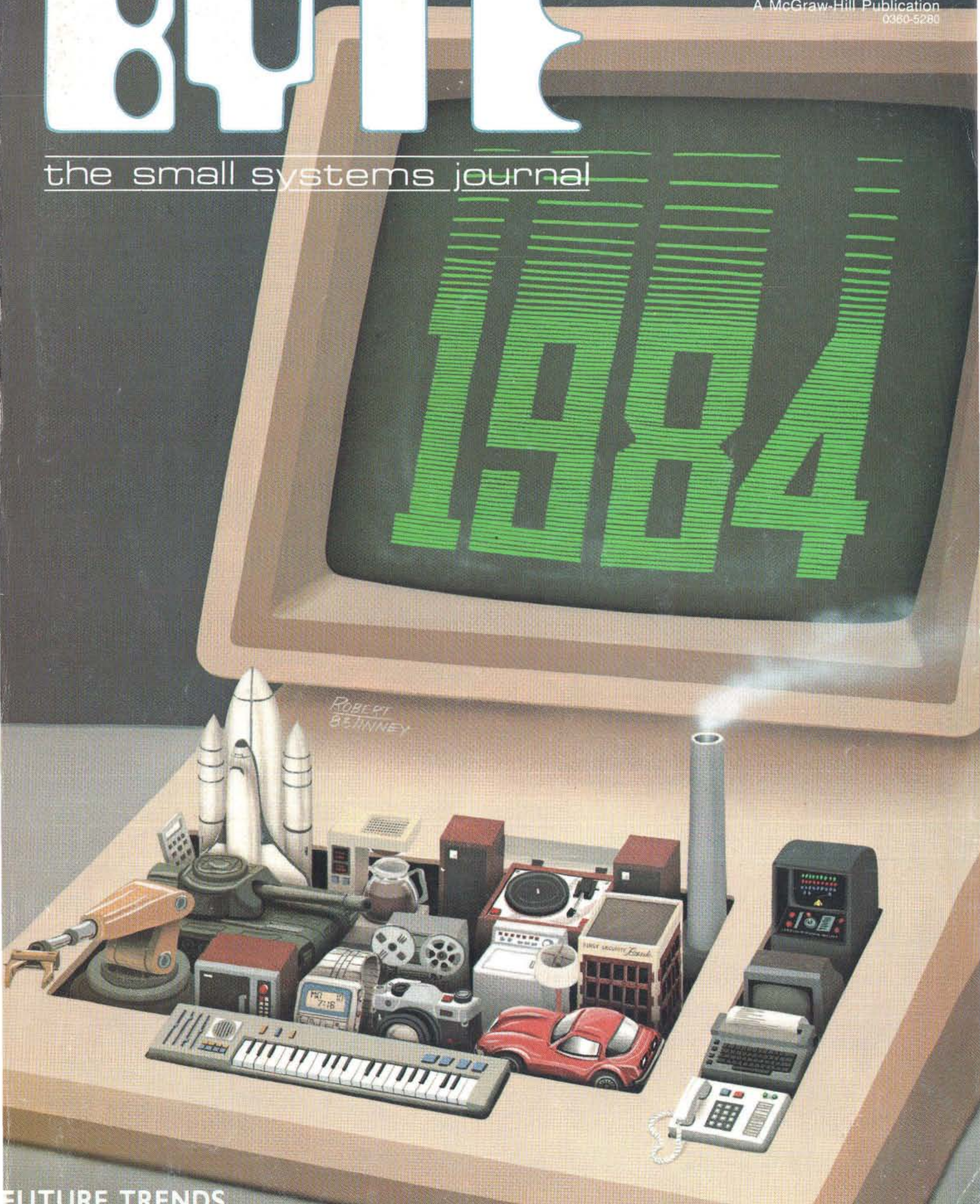

FUTURE TRENDS

Inside Apple

Vol. 1, No. 4

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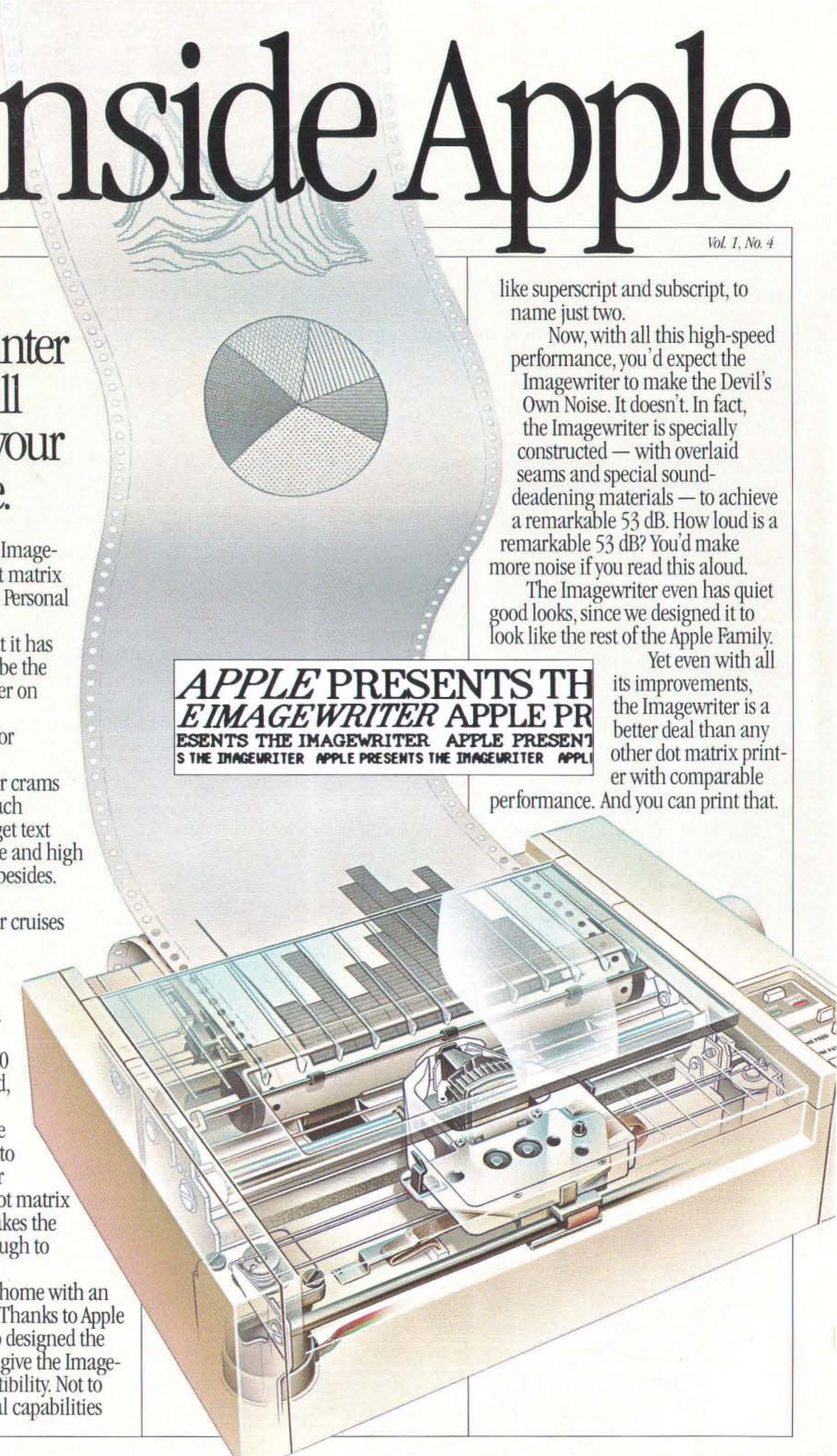

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In The Queue

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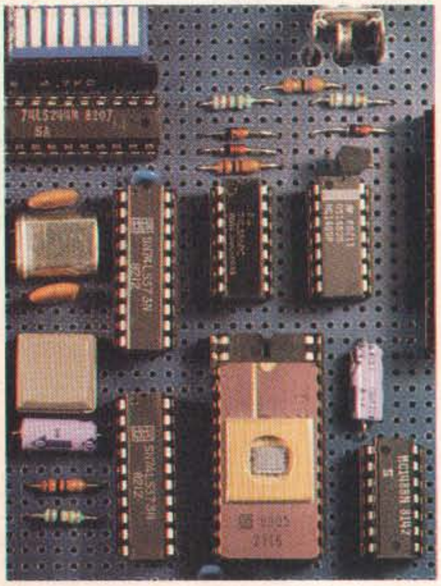

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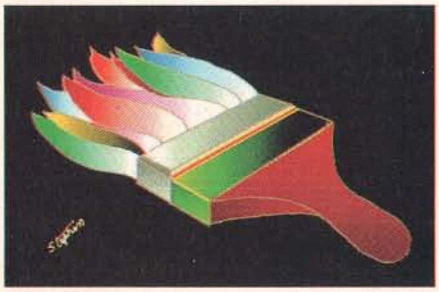

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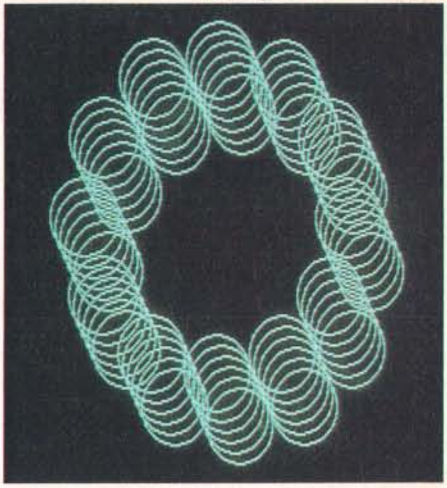

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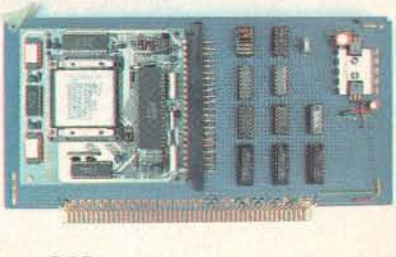

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Editorial

Revisiting the Luddites

As 1984 dawns, only a small fraction of the general population of this nation owns or regularly operates a computer. Indeed, there is still widespread concern that the increasing encroachment of computers into daily life carries with it the threat of substantial unemployment as computers displace people on the job. We think an article that appeared last summer in the Wall Street Journal *("The Luddite Answer to Unemployment") addresses the fears of those who remain unconvinced that computers aren't threatening. The article was written by Bruce Bartlett, executive director of the Joint Economic Committee of Congress. We've reprinted it here because we think Mr. Bartlett's views deserve an even broader audience. . . .* **Lawrence J. Curran, Editor in Chief**

In the early 1800s a group of British workers, concerned that the introduction of machinery was destroying jobs in the textile industry, went about destroying such machines in the hope of saving jobs. They issued proclamations in the name of the mythical King Ludd of Sherwood Forest and became known as Luddites. They still exist, although they no longer smash textile equipment. Instead, they issue dire warnings about how computers and robots are destroying jobs and will create an economic crisis unless the federal government adopts massive new programs to absorb the new unemployed.

Wassily Leontief, a Nobel laureate in economics, argues that increasing technology and automation will lower real incomes, as workers attempt to forestall technological innovation by reducing their wages. Nevertheless, he sees the tide of technology moving relentlessly onward, leaving in its wake a vast army of unemployed. Assemblyman Tom Hayden in California put the issue even more starkly:

"The economy is moving toward dependence on machines instead of human labor as a means of producing goods in each plant, and toward high-technology, capital-intensive industries in place of older, established craft or labor-intensive processes. As this 'progress' rolls on, fewer and fewer jobs are created per dollar invested. Each recovery from recession involves a greater investment of capital in expensive, high-tech industry, and this in turn makes greater unemployment a growing likelihood."

Echoing the Line

There is, of course, not a scrap of evidence in either theory or history to suggest that technological development won't increase employment and real incomes today just as it always has. Those who suggest otherwise are just echoing the Luddite line.

One can go back as far as Adam Smith for evidence. In the first chapter of "The Wealth of Nations" Smith tells his famous story about the pin factory where a single worker without machinery "could scarce, perhaps, with his utmost industry, make one pin in a day, and certainly could not make twenty." But with the introduction of machinery a single worker could make as many as 4,800 pins a day. Given the number of pinmakers in England at that time and the demand for pins, such machinery should have created about 99% un-

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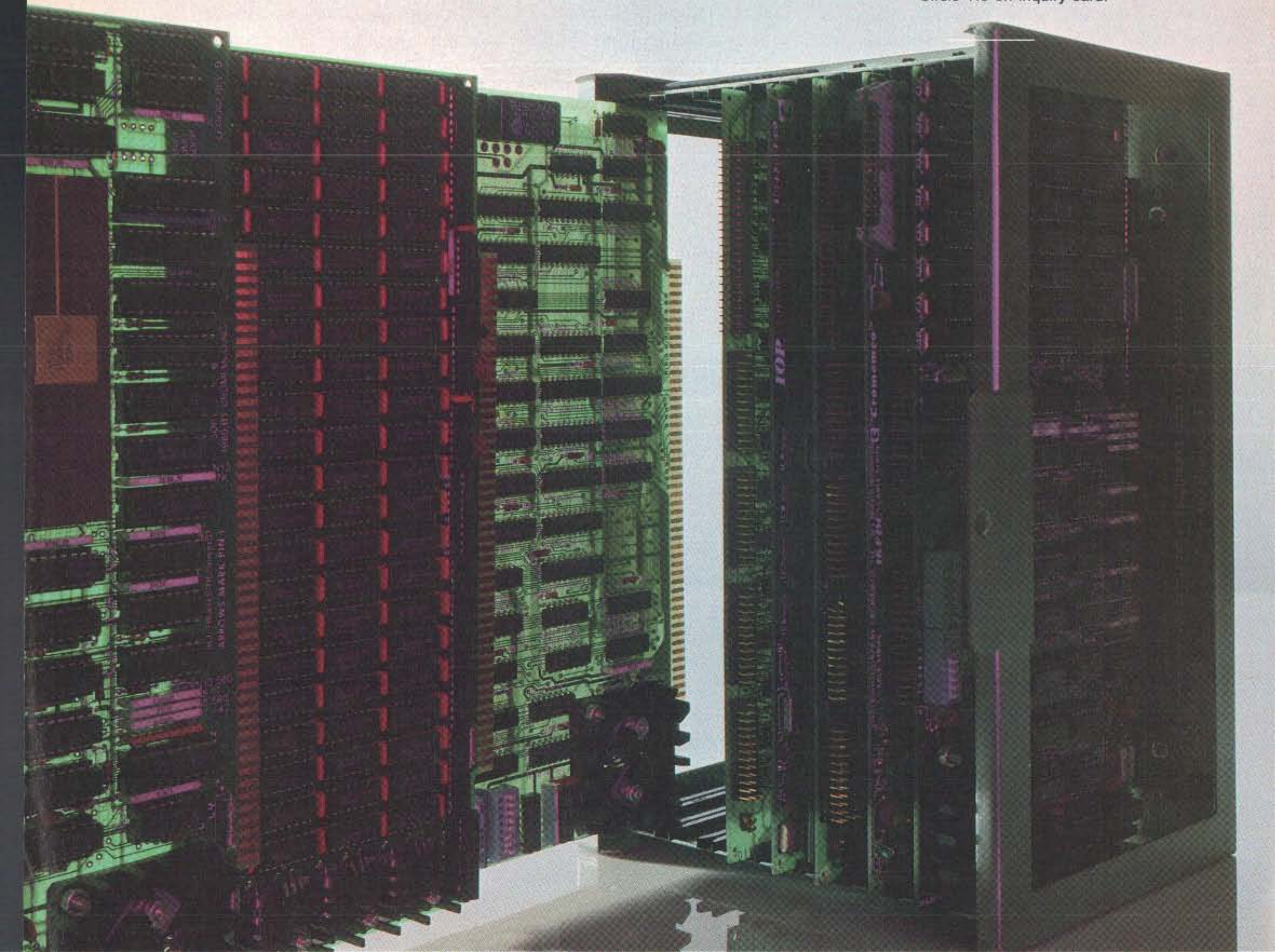

employment in the pinmaking industry. Obviously it did not because the vast increase in pinmaking productivity resulting from mechanization so lowered the cost of making pins that new uses for them were discovered. Moreover, the increased real income of those who previously used high-cost, handmade pins increased demand for other products and gave rise to employment in other industries, not the least being makers of machines for pinmaking.

Another aspect of the new Luddite argument is that rising productivity is not altogether a good thing. As Robert Kuttner asks in The Atlantic, "What would happen if all the physical goods were produced by robots? The one worker who flipped the switch would boast astronomically high productivity. What should he be paid? And what would everyone else do for a living?" Somewhat along these same lines I have heard members of Congress express concern that if productivity rises too rapidly in the current recovery more output will be achieved without reducing unemployment.

Again, the flaw is static analysis—assuming that things won't change, that technology and automation won't change relative prices or incomes, that the economy will essentially continue to produce the same goods in the same quantities only using less labor.

One might respond by asking what our economy would look like without rising productivity. In 1910 the Bell System had 121,310 employees. Approximately 7 million calls were placed that year, or 57 per employee. In 1981 the Bell System had 874,000 employees, who serviced over 219 billion calls. Had there been no increase in productivity since 1910 it would have required close to 4 billion employees to service that many calls. The result, of course, has been that telephones are widely available and calls can be made at very modest cost compared with 1910. This has given rise to vast numbers of jobs in every industry which simply couldn't exist without efficient, inexpensive phone service.

While it may be obvious in the long run that rising productivity and technological innovation create more jobs than they destroy, might there still be short-run adjustment problems to consider? According to two British researchers, J. D. Whitley and R. A. Wilson, who studied the employment effects of technological change in the British microelectronics industry, probably not. They identify interrelated factors that contribute to overestimates of employment loss from new technology.

> **'Those who dwell on the apparent adverse effects of technological change on employment are only creating unnecessary fear and anguish among workers...'**

First, people tend to overgeneralize from particular case studies. It might seem obvious that a firm employing 10 secretaries that could get the same work from one with a word processor would then lay off nine. But studies of firms adopting such technology indicate that actual job displacement amounts to about 10% of the potential effect. In this case, therefore, only one secretarial position is likely to be permanently lost in that firm.

Second, people tend to be overly optimistic about the speed at which new technology will be adopted. They imply that adopting it is somehow costless. Yet it is clear that creating and implementing technology requires previous investment in both physical and human capital.

Third, Whitley and Wilson found that there is a tendency to exaggerate the extent to which microelectronics represents a completely revolutionary technology. "Even if microelectronics represents the major source of technological change likely to occur during the 1980s and 1990s," they say, "it will need to result in a marked acceleration in the pace of improvement in productivity for it to displace labor faster than achieved by previous generations of technological change. The general consensus appears to be that the new technology is best regarded as a development from previous technologies rather than a revolutionary change." Again, the data indicate that the potential for job loss is much less than has been generally feared.

Unnecessary Fear

The authors might also have mentioned that to the extent productivity is enhanced it will forestall layoffs which might take place in plants and industries where union wage demands would otherwise exceed productivity growth.

The Luddite argument has no more validity today than it had in 1811. Those who dwell on the apparent adverse effects of technological change on employment are only creating unnecessary fear and anguish among workers who worry they will be laid off. Though they may not in fact advocate restrictions on the introduction of technology, as the Luddites did, they may be sowing seeds of discontent which could take root in other ways. Already there is pressure for trade restrictions, industrial policy, plant-closing laws and government bailouts for companies in declining industries. The new Luddite argument only adds to the pressure.

All this isn't to say that some specific individuals may not become unemployed as a result of technological change. Legitimate efforts should be made to ease their plight and help them find new work. But such instances shouldn't obscure the larger good to society from increased productivity. *—Bruce Bartlett*

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MICROBYTES

Staff-written highlights of late developments in the microcomputer industry.

COMDEX: IBM CLONES AND A NEW TANDY ENTRY

Two major electronics companies, including one of the pioneers of the computer industry, jumped into the crowded market of IBM PC compatibles at last month's Comdex show in Las Vegas. Sperry Corp., inventor of the Univac mainframe, introduced its Sperry Personal Computer. Sperry says its PC is fully compatible with the IBM but can run 50 percent faster and can talk to both Sperry and IBM mainframes. Prices range from $2643 (one floppy-disk drive, 128K bytes of RAM, and a monochrome monitor) to $5753 (one 10-megabyte Winchester, one floppy disk, 128K RAM, and a color monitor). Lower-priced models are scheduled to be available this month. . . .ITT Corp. showed its XTRA computer, which is claimed to be operationally compatible with the IBM PC. Major features of the XTRA include a mouse, 128K to 640K bytes of RAM, color graphics, a processor-unit footprint 30 percent smaller than IBM's, and prices about 5 percent lower than comparable IBM units. . . .Radio Shack introduced its Tandy Model 2000, an MS-DOS system using an 8-MHz Intel 80186 central processor instead of the 4.77 MHz 8088 of the IBM PC and look-alikes. The Model 2000 retails for about $3000 with two disk drives and a monochrome monitor or $4400 with a 10-megabyte hard disk. . . .Radio Shack also announced that it will support the Ovation software package for the Model 2000. Ovation is a modeless word-processor, spreadsheet, information-management, graphics, and communication package.

COMDEX: A HARDWARE DATABASE HELPER

Cogent Data Technologies borrowed an idea from the mainframe and minicomputer worlds to develop a back-end processor for database processing in multiuser systems. Its Database Machine— a card for the IBM PC, XT, and 3270-PC—incorporates Winchester control, database commands, and a multitasking operating system. Using an on-board 80186 chip as a coprocessor allows 64K-byte files to be written in just over a tenth of a second, Cogent claims. One card will be needed for each hard disk in a network and will cost from $1500 to $1700.

COMDEX: INTEGRATED SOFTWARE

Among the many integrated software packages making their debuts were 20/20 from Access Technology Inc. and DayFlo Inc.'s Personal Information Manager. 20/20 will run on numerous micros, minis, and mainframes. It incorporates spreadsheet modeling, graphics, data management, scheduling, text processing, and interfaces to external programs. It will sell for about $500. . . .DayFlo allows free-form data entry, revision of formats of existing files, word processing, note-taking, forms design, and integration of external programs such as spreadsheets. It runs on the IBM PC and costs $495.

COMDEX: OPERATING SYSTEMS

Digital Research Inc. introduced two new versions of Concurrent CP/M, a generic version for OEMs and an IBM PC end-user version featuring windowing. DRI says the OEM version is compatible with PC-DOS and supports DR Soft/Net, networking software also introduced by DRI at Comdex. The end-user package will be available through April 1 at promotional prices starting at $150. . . .Cosmos Inc. announced that it is now an authorized Pick system licensee. Cosmos was showing its Revelation relational database-management system for the IBM PC. The Revelation system allows both MS-DOS and Pick applications to run on the PC. (Pick Systems, the developer of the program, will offer an implementation for the IBM PC XT sometime this quarter.)

COMDEX: A 32-BIT MICRO

Silicon Valley Micro Inc. introduced two 32-bit portable computers with some IBM PC compatibility. Descriptively named the $5000 Model and the $10,000 Model, each features both a National Semiconductor NS32032 microprocessor and an Intel 8088, an 80-column thermal printer, a 9-inch, 80 by 25 monitor, a Unix subset and MS-DOS, and serial and parallel ports. In addition, the $5000 Model has two half-height 360K-byte floppy-disk drives and 512K bytes of RAM. The $10,000 Model adds a 140-megabyte hard disk, a ¼-inch 60-megabyte tape drive, and 2 megabytes of RAM.

COMMITTEE ON IN-FLIGHT COMPUTER USE WAITS FOR TEST RESULTS

"Very few airlines that allow portable computers on their planes have actually tested them," said Andreas Fraga, chief avionics engineer at Eastern Airlines, after the December meeting of SC-156, the committee studying potential hazards portable computers might present to airplane navigation equipment. Convinced that "ignorance is our worst enemy," Fraga wants testing before portable computers are used in planes. One possible result of the study might be a list of approved computers that flight attendants could refer to. Only three computer manufacturers and five airlines sent representatives to the meeting. Committee SC-156 of the Radio Technical Commission for Aeronautics meets again February 28–29 in Washington, when preliminary test results may be available.

APPLE ANNOUNCES INTEGRATED SOFTWARE, HARD DISK FOR THE APPLE IIe

Apple Computer has unveiled Apple Works, a $250 integrated software package for the Apple IIe that includes a word processor, a database manager, and a spreadsheet. A similar program for the Apple III, called III E-Z Pieces, will be available this month. Apple also announced that the Profile, a 5-megabyte hard-disk drive previously available only for the Apple III and the Lisa, will be available for the Apple IIe for under $2200.

INMOS ANNOUNCES A 32-BIT 10-MIPS "TRANSPUTER"

Inmos Corp. has announced the IMS T424 transputer, a 32-bit microprocessor with 4K bytes of on-chip high-speed (50-nanosecond) RAM. Inmos says the transputer will execute an average of 10 million instructions per second.

UNIX ADDED TO DEC PROFESSIONAL, IBM PC XT, AND APPLE LISA

The Santa Cruz Operation Inc. announced that it will market Microsoft's Xenix operating system for the IBM Personal Computer XT, the Digital Equipment Corporation Professional 350, and the Apple Lisa for $595 to $795.

Digital Equipment Corp. announced PRO/V7M, based on Unix version 7, which will cost $695 for its Professional Computer.

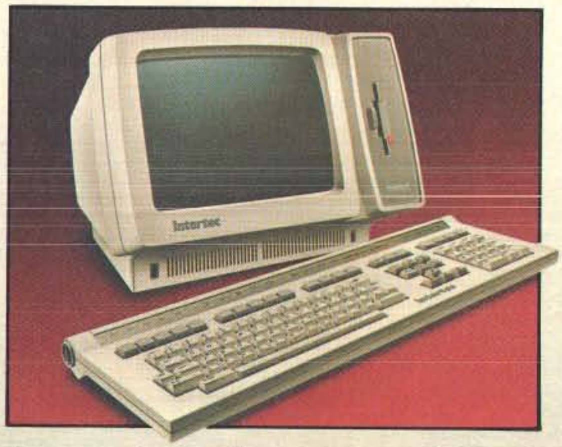
FOUR COMPANIES OFFER IBM COMPATIBLES WITH EXTRA FEATURES

Seequa Computer Corp. and Intertec introduced dual-processor IBM-compatible computers, both with 8086 and Z80 processors. The Seequa XT includes a 10-megabyte hard disk for $3995, without a monitor. Intertec's HeadStart, with a 3½-inch floppy-disk drive, is priced from $3495. North Star Computers Inc. and Onyx Systems Inc. introduced multiuser 80186-based computers. The North Star Dimension allows up to 12 users to access the system, which includes a 15-megabyte hard disk and two workstations for $7000. Onyx's 186 Series allows multiple users to use Concurrent CP/M-86, or a single user may use MS-DOS; a single-user system is $4495.

NANOBYTES

Dysan Corp. is entering the software publishing business in an effort to enhance the market position of 3¼-inch disks and drives. Dysan plans to enhance and standardize the documentation of the top 100 software packages and market them on 3¼-inch disks. . . . **Tandon Corp.** announced that it will begin selling 10- and 15-megabyte hard-disk subsystems to IBM Personal Computer users through dealers. Previously, Tandon sold products only to manufacturers. . . . **Digital Research Inc.** has announced a FORTRAN-77 compiler that was developed using a new technology DRI says will enable it to develop and translate compilers more quickly than in the past. . . . **Tri-Data** has unveiled the Oz Guardian, a $750 modem that verifies passwords before permitting access to a system. The modem may be programmed to hang up and call back the phone number associated with that user. . . . **Softech Microsystems Inc.** has announced a family of network software products based on its p-System operating system. Initially available for Corvus's Omninet, software for up to eight users costs $750. . . . **Eastman Kodak** has announced that it will manufacture and market Drivetec's high-density 5¼-inch disk drive for use in image storage and analysis applications. Kodak hopes to use its Isomax high-density disk with the drive, which can store 2.8 megabytes of data on a high-density disk. . . . **Lotus Development Corp.** is reportedly working on a version of its popular 1-2-3 spreadsheet program for Motorola's 68000 microprocessor.

Introducing The Computer That Blew Their Socks Off At Comdex.



HeadStart™ is the smallest, smartest, fastest, most powerful business computer you can buy. And networkable up to 255 user stations.

Fast? HeadStart's RAM Disk concept permits nearly 50 times faster response than conventional microcomputers. 8 or 16 bit and up to 1 megabyte of user memory.

For more information, call or write: Intertec, 2300 Broad River Road, Columbia, SC 29210. Phone 803/798-9100.

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Introducing COMPAQ PLUS, the first high-performance portable personal computer.

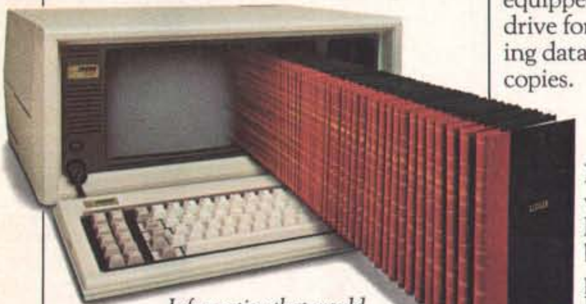
The makers of the COMPAQ™ Portable Computer, the industry standard, announce another breakthrough—the COMPAQ PLUS™ Portable Personal Computer. No other personal computer can handle so much information in so many places.

The new COMPAQ PLUS offers the power of an integrated ten-megabyte fixed disk drive in a portable. You get problem-solving power that no other personal computer can match.

Plus a bigger payload

How much is ten megabytes?

Enough to tackle jobs that can't be conveniently handled on most personal computers.



Information that would fill your company's ledgers can be stored on the fixed disk drive of the COMPAQ PLUS.

A mailing list of 100,000 names, addresses, cities, states, and Zip codes.

A full year of daily prices for every stock on the New York exchange.

Inventory records on a quarter million items.

The entire San Francisco phone book. And room left over for Peoria.

The fixed disk drive keeps all the information seconds away, ready to be searched, sorted, retrieved, analyzed or updated.

Plus better use of your time

The integrated fixed disk drive will store programs. That means your most used programs and data can be permanently kept in the COMPAQ PLUS, ready to call up and run.

With programs permanently stored, the COMPAQ PLUS becomes a well-informed traveling companion, a tool to help you apply your best thinking anytime, anywhere.

You could store a complete library of accounting programs on the disk—payables, receivables, general ledger, and payroll—*with* the company's books.

You could store an inventory control program with your inventory records and a list management program with your mailing list and a filing program with your personnel files.

The COMPAQ PLUS is also equipped with a 360K byte diskette drive for entering new programs, copying data files, and making backup copies.

Plus more programs

More programs means more versatility. And the COMPAQ PLUS is impressively versatile because it runs all the popular programs written for the IBM® Personal Computer XT, available in computer stores all over the country. And they run as is, with no modification whatsoever.

And the high-capacity portable multiplies the productivity of every program it runs. Your inventory and its control programs can go with you to the factory. Your books and your accounting programs can go with you to a board meeting. Your building specs and your project management programs can go with you to the construction site.

You're buying a computer to solve problems. Why not have more problem-solving programs to choose from?

The COMPAQ PLUS runs all the popular programs written for the IBM Personal Computer XT.

Specially designed shock isolation system protects the fixed disk from jolts.

Plus a traveler's toughness

Life can be tough on the road. A true portable has got to be tougher. The COMPAQ PLUS is.

Its integrated fixed disk drive is unique, designed specifically to travel. Rough roads and hard landings don't bother it because of a specially designed shock isolation system that protects the disk from jolts and vibration.

All the working components are surrounded by a uniquely cross-membered aluminum frame. This structure, common in race car design technology, strengthens it side-to-side, front-to-back, and top-to-bottom.

The outer case is made of LEXAN®, the same high-impact polycarbonate plastic used to make bulletproof windows and faceplates for space suit helmets.

Does a portable personal computer really have to be this tough? Take a good look at your briefcase and then decide.

Plus ease of use

The COMPAQ PLUS is big where it counts.

The display screen is big. Nine inches diagonally. Big enough to show a full 25-line-by-80-character page that's easy to read even if you're leaning back in your chair.

The keyboard is full-sized and typewriter-style for easy control.

With its built-in display, the COMPAQ PLUS makes a smooth, low profile on your desk, not an obstacle that you have to talk around.

Plus an easy way to get started

If you're buying your first personal computer and you're not sure how much capacity you need, your choice is easier now.

Start with the COMPAQ Portable with single or double 320K byte diskette drives. If you need more capacity later, upgrade to the COMPAQ PLUS. A conversion kit is available that turns the COMPAQ Portable into a COMPAQ PLUS, complete in every detail and capability.

Plus a lot more

The COMPAQ PLUS also works with optional printers, plotters, and communications devices designed for IBM's personal computer family.

It has two IBM-compatible slots for adding optional expansion boards. With companion programs, they'll let you share information with a network of personal computers in your office, communicate with your headquarters computer files while you're away, or add memory capacity if your needs grow.

The problem-solving power of a high-performance desktop personal computer can now go where you need it.

It's got high-resolution graphics and text on the same screen. A detached keyboard. Programmable function keys. Expandable memory. Dozens of other features that simply make it do a better job of personal computing.

And when you see all that the COMPAQ PLUS has to offer, you'll be pleasantly surprised by the price. The fact is, it costs hundreds less than comparably equipped desktop personal computers.

See the first high-performance portable personal computer. The COMPAQ PLUS—performance, programs, productivity. Plus problem-solving power.

COMPAQ PLUS Specifications

Storage
- ☐ One integrated 10-megabyte fixed disk drive
- ☐ One 360K byte diskette drive.

Software
- ☐ Runs all the popular programs written for the IBM XT.

Memory
- ☐ 128K bytes RAM, expandable to 640K bytes

Display
- ☐ 9-inch diagonal monochrome screen
- ☐ 25 lines by 80 characters
- ☐ Upper- and lowercase high-resolution text characters
- ☐ High-resolution graphics

Interfaces
- ☐ Parallel printer interface
- ☐ RGB color monitor interface
- ☐ Composite video monitor interface
- ☐ RF modulator interface

Expansion board slots
- ☐ Two IBM-compatible slots

Physical specifications
- ☐ Totally self-contained and portable
- ☐ 20″W × 8½″H × 16″D

For the name of the Authorized Dealer nearest you, call 1-800-231-0900.

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The COMPAQ Portable, the industry standard in portable personal computers. ▼

The new COMPAQ PLUS, the first high-performance portable personal computer. ▼

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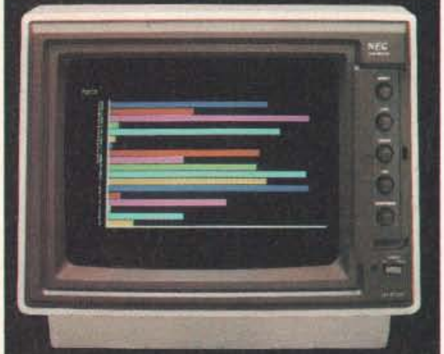

Get the total picture.

IBM COMPATIBLE - $599!

Improve your present computer system with a high-resolution color monitor from NEC.

NEC's JC-1216 gives you the highest resolution you can get in a color monitor. And it can reproduce as many different colors and shades as the best microcomputers can generate. Compatible with a wide variety of computers, including IBM,®* Zenith,® H-P,® and others, including NEC's own PC-8000 and PC-8800.

Compare these specs with your present monitor:

12-inch diagonal screen

RGB input signal with TTL level

Switchable Pos/Neg display characters

80-character, 25 line display

640(H) x 240(V) resolution

8 x 8 dots, 10MHz video bandwidth

*NEC CG-91 cable required

Productivity at your fingertips

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Personal Computer Division
1401 Estes Avenue
Elk Grove Village, Il 60007
(312) 228-5900

NEC Corporation, Tokyo, Japan

Letters

In Praise of the Morrow

I have just finished "The Morrow Micro Decision" (October, page 306) by Tom Wadlow. As the satisfied owner of one of these fine machines, I must take exception with a few of his statements.

A user does not have to suffer the indignities inflicted by the Control key. This is the only review on the Morrow that I've read (and I've read at least three others) that does not mention that Morrow offers two terminals. The more expensive terminal has a much more professional "feel"; the Control key is located beside the Lock key.

I agree with the complaint about the ports. However, the latest advertisements show that a parallel port has been added. Didn't the author get the latest information before writing his review? The MD-11, another recent introduction, should also have been mentioned. It offers hard-disk storage.

As a first-time microcomputer user, I found the documentation quite adequate. Perhaps Mr. Wadlow would prefer Apple; as far as I know, you still have to pay extra for its documentation. As far as configuring the terminal, I cannot imagine a dealer who would not assist in this admittedly distasteful task.

My only real complaint is that I am still waiting for the database manager.

I guess the Morrow ads are correct; maybe it does take a special breed to recognize the value of the Morrow machines.

Gregory Diehl
Data Processing Consultant
2561 Hungary Spring Rd.
Richmond, VA 23229

Two other major microcomputer publications reviewed the Morrow Micro Decision small-business computer in September. Based on these reviews and my own 11-month experience as an MMD owner, I can only conclude that Tom Wadlow's October review was superficial because of an impending deadline.

In any case, I believe Mr. Wadlow seriously underestimated a machine that may be the best buy available for the first-time business user uninterested in portability.

I have tried in vain to explain to colleagues the utility of the MMD's "virtual-drive" feature for saving files when confronted with a filled-up disk, for copying files from one disk to another without leaving Wordstar, and for other ways to avoid a few of the irritations that plague users.

I appreciate the CP/M interrupt that allows me several tries at a BDOS (basic disk operating system) error before giving up and retreating to the operating system. Although I'm sure other manufacturers could offer these BIOS (basic input/output system)/BDOS modifications, I know of no other under-$2000 microcomputer that does. Do any over-$2000 machines offer them?

Similarly, I've found the disk-emulation feature convenient; friends and coauthors with Osbornes or IBMs simply mail me a disk if they don't have a modem. I wish Mr. Morrow had included a disk-formatting option as well, so I wouldn't have to stockpile supplies of my friends' disks.

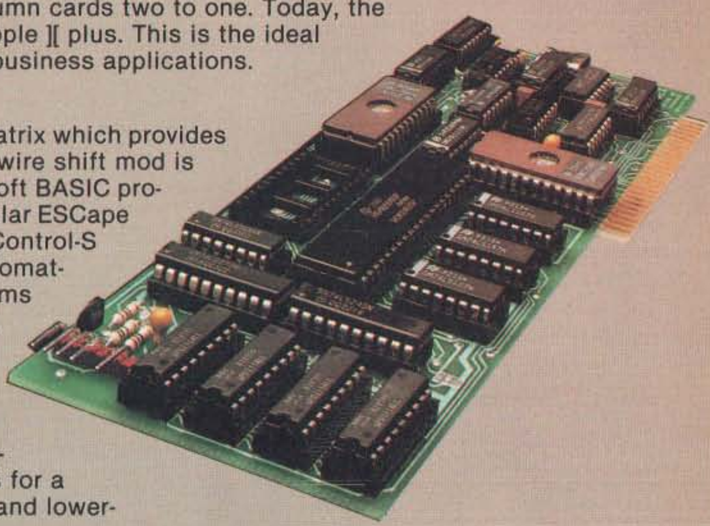
In the only "benchmark" in the review, Mr. Wadlow says the bundled Correct-It spelling checker is slow in "loading and sorting," based on his "test" of a single sentence of 14 words. As anyone who has used various spelling checkers knows, most of the time in operating these packages is spent checking the sorted object file against the master dictionary. My own "test" (without leaving Wordstar, thanks to the MMD virtual-drive feature) found that Correct-It took only 5.6 seconds to "load and sort" this 334-word letter. It then took another 75 seconds to check each of these words against its 36,000-word dictionary. Given what a spelling-checker does, I submit that this is *not* slow.

Mr. Wadlow may have revealed himself as a dedicated "Selectric" keyboarder when he complained about the location of the Control key on the MMD keyboard. As in almost all Lear-Siegler ADM terminals, the Control key is conveniently located in an easily learned position, immediately below the Z key. But those used to stretching beyond the left-hand shift key (as on Apples, IBMs, and many other terminals) will have trouble adjusting. I can assure Mr. Wadlow that the only drawback to an experienced user is the difficulty of making a one-hand stretch to achieve "Ctrl-Y" (line-delete in Wordstar), and I have often thought of this as fortunate.

My fellow members in the Morrow Micro Decision Users Group have found

Videoterm™ The Best Selling 80-column Card For Apple®

By the end of 1982, the Videoterm had outsold all other 80-column cards two to one. Today, the Videoterm continues to be the standard for the Apple][and Apple][plus. This is the ideal 80-column card for word processing, spreadsheets, and other business applications.



With the Videoterm, you can display your text with a 7 x 9-dot matrix which provides upper and lower case letters with true descenders. The single-wire shift mod is also supported. The Videoterm will list both Integer and Applesoft BASIC programs using all 80 columns without splitting keywords. The popular ESCape sequence editing capabilities and a stop-list function using Control-S are supported. If you install the Videoterm in Slot #3, it will automatically be used by Pascal and CP/M, since these operating systems recognize the Videoterm as a standard video display terminal.

Apple //e Kit

This kit contains an OPTIONAL Videoterm firmware and a redesigned softswitch for the Apple //e. This OPTIONAL firmware is for a BASIC programmer and includes: NORMAL, INVERSE, HOME, and lowercase entry of BASIC commands.

The Videoterm has no trouble keeping up with 1200 baud modems during normal printing or scrolling. The Videoterm is not compatible with cards plugged into the auxillary slot of the Apple //e. For this situation, we recommend the UltraTerm display card.

Videoterm Utilities Disk

The six programs on the Videoterm Utilities Disk will complement the creativity of the 80-column screen. This disk contains:

GRAPHICS TEMPLATE — Create a business form in 80 columns

SCROLL UTILITY PROGRAM—Set a window in 80 columns

FONT EDITOR—Create new character fonts

READ SCREEN—Read characters from screen locations

PASCAL DEMONSTRATION PROGRAMS

VIDEXGRAPHICS—Provides MID-RES Graphics in Pascal

MID-RES GRAPHICS—Graphics in 80 columns

Alternative Characters

Spanish

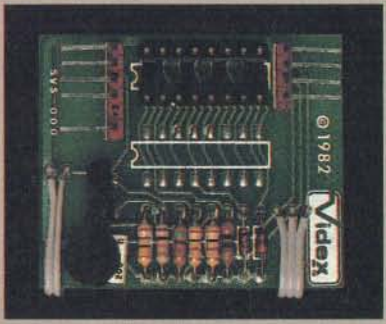
§ ¡ Ñ ¿ ` ° ñ ç ~

French

£ à ° ç § ` é ù è

The Videoterm comes with ASCII standard character set. There is a second socket for an alternate character set. You may choose from foreign languages, inverse, underline, APL language, symbol math and Greek), and line drawing graphic character sets.

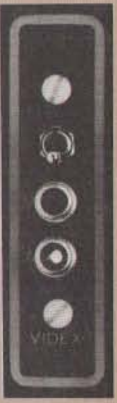
Soft Video Switch



The Soft Video Switch knows whether it should display 40 or 80 columns or Apple graphics. It does the tedious work of video-switching so you don't have to.

Switchplate

Some programs (especially those that use Run-Time Pascal) write directly to the 40-column text page and do not use standard video-switching protocol. For these programs, the Switchplate allows you to easily toggle to the 40-column video output.



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Videx
1105 N.E. Circle Blvd.
Corvallis, OR 97330
503-758-0521

many ways they can use the Micro Decision as a fully equipped, low-cost solution to business needs. I only hope BYTE will assign a more sophisticated reviewer to Mr. Morrow's latest offspring, the 11-megabyte/128K/$2745 MD-11 (with bundled software, of course).

Andrew J. Boots
2619 Washington Ave.
Chevy Chase, MD 20815

In "The Morrow Micro Decision" Tom Wadlow states that, "The basic drive is single-sided single-density and stores about 200K bytes." I do not think this can be true because my machine has single-sided double-density disks on it. They hold only about 200K bytes.

He implies, at the end of the same paragraph, that programs written for the IBM PC can be run on the Micro Decision. This statement, the way it is worded, is inexcusable from a reviewer. How can one run a program written for a 16-bit machine on an 8-bit machine? While the format is readable, unless the program is written so that the Z80 can read it, it is unusable.

Also, he should have admonished people to be careful with any compatible software, i.e., Xerox 820, Osborne I. These program formats are usable only if there has been no configuration in the software that addresses the hardware ports, etc. If they are not written to be transportable, they will not work. Most of the software manufacturers that I have contacted are not sure if their Xerox or Osborne formats will run on the Micro Decision. If they don't, you may lose the price of the software, unless you can go inside and rewrite that part of the software.

I don't know where Mr. Wadlow got his prices, but an ad in the same issue lists different prices for the MMD. But the point of his article that really made me mad was his assessment that "The Micro Decision would make a good second computer for people who are familiar with CP/M systems or for those who have had experience with computers." Because I do not fall into either category, I have to interpret that Mr. Wadlow thinks the system would not be good for me. However, I did not have any trouble with the MMD. I found the turnkey menus to be invaluable. Had I purchased a system that was not supported in the way the MMD was, I would probably have been turned off by computers. Instead, I am enthusiastic about them. I have learned the 8080 assembly language and have started writing many programs. I would not hesitate to recommend the MMD to someone who had never laid hands on a computer system before. In all fairness, I think that Mr. Wadlow's evaluation was somewhat biased simply because he was not a novice user.

David M. Gambs
2612 N.E. Skidmore
Portland, OR 97211

Tom Wadlow responds:

In my opinion, the purpose of a review is threefold: first, the equipment should be reviewed to see if it lives up to the manufacturer's claims; second, the equipment should be compared with the competition and its merits and faults should be brought to light; and third, a machine should be examined to see if it is all it should be—i.e., does it have any serious design errors?

I seem to have stepped on some toes with my review of the Micro Decision. Non-Micro Decision owners said they appreciated the review because it suggested things they should watch out for when purchasing any machine. Micro Decision owners' opinions were mixed. Some said the machine was a mistake and they would not recommend it to anybody. Others think it's the best thing since peanut butter. I think it is a good machine with some problems that should be examined out in the open, not hidden under the gloss of an undercritical review.

Terminals:

The BYTE article pipeline is unfortunately long and, as you can see, this sometimes causes problems. The system I received from Morrow had an ADM-20 terminal, and Morrow was not supporting the Liberty at the time. I had never touched a Liberty (I have since) and therefore could not make any comments about it.

Keyboard:

Over the course of my career, I have extensively used approximately 25 different keyboards ranging from keypunches and teletypes to my current Lisp Machine keyboard (which has seven different kinds of shift keys, any combination of which may be and often is used with a single alphanumeric character). The issue of the "best" keyboard is touchy. I will simply settle for saying that the ADM-20 keyboard is far from the "best." The Liberty is much better.

Compatibility:

If you read the first paragraph under Disk Storage in my article, you will see that I did not say that programs written for the IBM-PC can run on the Micro Decision. I said that conversion programs to run on the Micro Decision that allow you to read IBM PC disks (which implies text files only, since binary files would be useless to the MMD) are available.

MD-11:

The MD-11 was announced just shortly before the October issue of BYTE hit the stands. And prices can change dramatically over the large fraction of a year between submission of an article and its publication.

I still stand by my review.

Name Change

We appreciate David Fiedler's mention of us in the table accompanying "The Unix Tutorial, Part 2" (September, page 257). However, we changed our name from Unisoft Inc. to Unicorp Software Inc., to avoid confusion with Unisoft Systems Corp. of Berkeley. Also, there was a typographical error in our phone number. The correct number is (212) 307-6800, *not* (212) 327-6800 as published.

Mark Pearson
President
Unicorp Software Inc.
303 West 42nd St.
New York, NY 10036

Unix Update

In my recent article on Unix typesetting ("Typesetting on the Unix System," October, page 253), I did not want to sound negative about either Scribe or TEX, nor did I intend to portray any formatting system as being better than the others. There is at least one factual error in the article: TEX does not *require* non-ASCII symbols, but rather provides an alternative to using them (various escape sequences).

Good documentation—*The TEX Book*—was scheduled for publication by Addison-Wesley in late 1983. TEX is actually written in WEB, a Pascal preprocessor language that is capable of producing code for a wide variety of machines. A new macro package to produce tables (a TBL equivalent) and a set of bibliographic for-

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mats (using a Scribe-like database) are now available.

There are two important ways in which TEX surpasses troff when measured by traditional typesetting standards. First, TEX provides kerning, whereas troff does not. Kerning is the moving of small letters underneath large overhanging letters, as in the digraphs To and Ve. Second, TEX and Scribe allow for different design sizes, while troff has width tables for only a single design size. Traditionally, good type designers always drew several variations of a single typeface to suit the optical requirements of different print sizes. Current trends point back to this tradition.

Bill Tuthill
Imagen Corporation
2660 Marine Way
Mountain View, CA 94043

The Model 4's Hitches

All in all, I was quite pleased with Rowland Archer Jr.'s review of the new Radio Shack TRS-80 Model 4 (October, page 292). I recently purchased a 64K-byte two-disk-drive version myself, and I am glad that I did. However, as with all things electronic, there are always a few hitches and glitches and compromises. Some of the problems with the TRS-80 were covered in the Archer article; however, there are a few niggling gripe points that he either failed to uncover or simply omitted for lack of space.

For one thing, there is the matter of the on-board speaker and the sound that can be generated with a new statement in TRSDOS 6.0. I defy anyone to find a reference to that statement and the method for its use in either the BASIC section of the *Disk System Owner's Manual* or in the Radio Shack Model 4 *Quick Reference Guide*. (Or, for that matter, in any other piece of documentation that comes with your new computer.) In order to be able to make use of this feature, I had to contact my dealer, who in turn had to call the nearest Radio Shack Computer Center, who then informed us of the following:

1) The proper statement syntax is SOUND X,Y where X is the pitch and Y is the duration.

2) The permissible range of values for pitch is 0–7.

3) The permissible range of values for duration is 1–31.

He then gave us the following program with which to provide ourselves with a demonstration of the Model 4's sound-making capabilities:

```
10 FOR X=.1 TO 7 STEP .1
20 PRINT X
30 SOUND X,1
40 NEXT X
50 END
```

Unfortunately, I was not impressed. This feature, with its limited ranges of both pitch and duration, is less than useless. Radio Shack could have omitted it and no one would have missed a thing. Fortunately, one is still able to generate a regular range of TRS-80 sound through the previous method of sending the appropriate values to an output port. (After doing some reading about the Job Control Language features of the Model 4, I realized that the primary reason for the inclusion of this piddley sound capability was for use as an alerting device when the computer is being used for a multiplicity of different processing tasks in a business or other office environment.)

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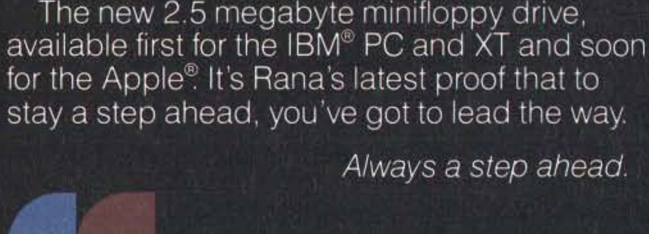

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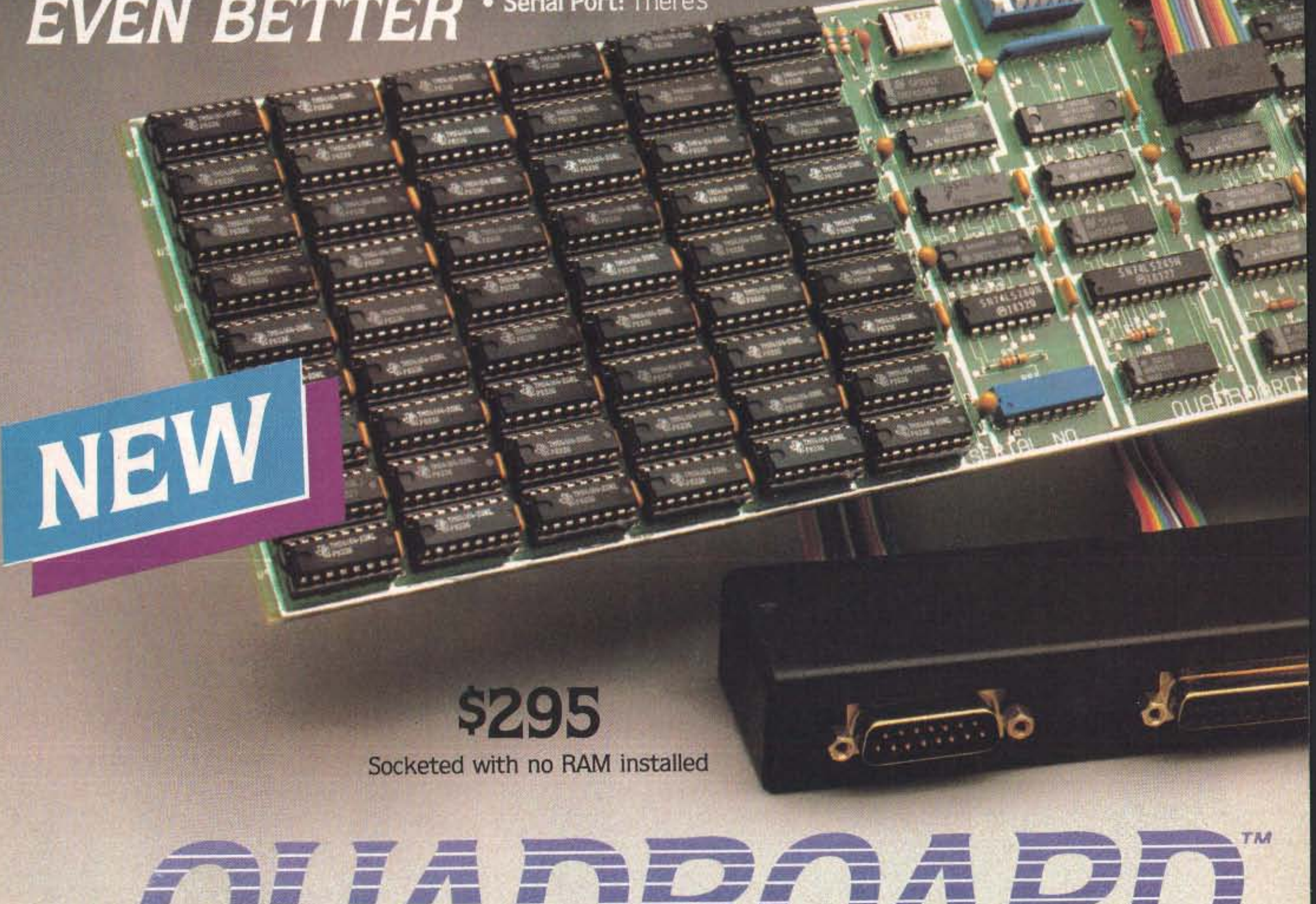

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Perhaps Radio Shack should have taken the money that was spent on incorporating that insipid attempt at a sound statement and spent it on providing the Model 4's keyboard with a functioning "ON" light. After the computer has been turned on and before TRSDOS has been booted up, there is absolutely no way to tell that it is on: no cursor on the screen and no lights on the keyboard or front panel. It's such a simple thing, yet it seems to have completely slipped the attention of the engineers at Radio Shack. And it is important: I've had my Model 4 for only two months and I've already inadvertently left it on overnight several times (once with the cover on it).

And, of course, there are the seemingly obligatory documentation typos and ambiguities. When attempting to get the communications software that is included with TRSDOS 6.0 (a useful and sophisticated program, I might add) up and running, the unsuspecting Model 4 user is led on a wild goose chase for an appendix that doesn't exist: the included reference to Appendix L should have been to Appendix I. Once I got the Comm program going and experienced difficulty in downloading a file from my disk space in Compuserve, I discovered that the problem lay with the instructions for transferring a file from a mainframe to a TRS-80. We are first told to "Type in the command which causes the mainframe to list the file, but do not press <ENTER>." The next instruction tells us to "Specify your receive file by pressing <CLEAR><6> followed by <CLEAR><9>," after which we are to type in the filename in response to the prompt. The third step begins by instructing the user to "Press <CLEAR><6> followed by <CLEAR><:> to open the receive area of memory." If the file to be downloaded is smaller than the available area of memory, we go to the next instruction. We are then told to "Press <ENTER> to start the file listing." The instructions are both clear and quite detailed, but the confusion results from assuming the user, who is being walked through the procedure verbatim, will suddenly break out of the rote mold and provide one key step that they have assumed to be one of common sense. When I attempted to carry out these instructions, I began by issuing the prescribed FILGE command to list my file:

```
TYPE filename
```

but did not press <ENTER>. I then did the <CLEAR><6><CLEAR><9> to specify my receive file. The Comm program responded with the appropriate prompt and I typed in the filename

```
Filename: filename
```

Now, anyone with an ounce of computer literacy knows that, ordinarily, in order to get the computer to "take" the information that has just been typed on the keyboard, the user must press <ENTER>; but remember, the instructions have been set up for the user to follow precisely, step-by-step. The first instruction told us not to press <ENTER> in a situation where we normally would have, and the first half of the second instruction had us press keys that caused the computer to do something without having to press <ENTER>. So the immediate assumption, at least on my part, was that I was not to press <ENTER> again until explicitly instructed to do so in the fourth step of the procedure. Therefore, without pressing <ENTER> after typing in the name of the receiving file, I tried to open the receive area of

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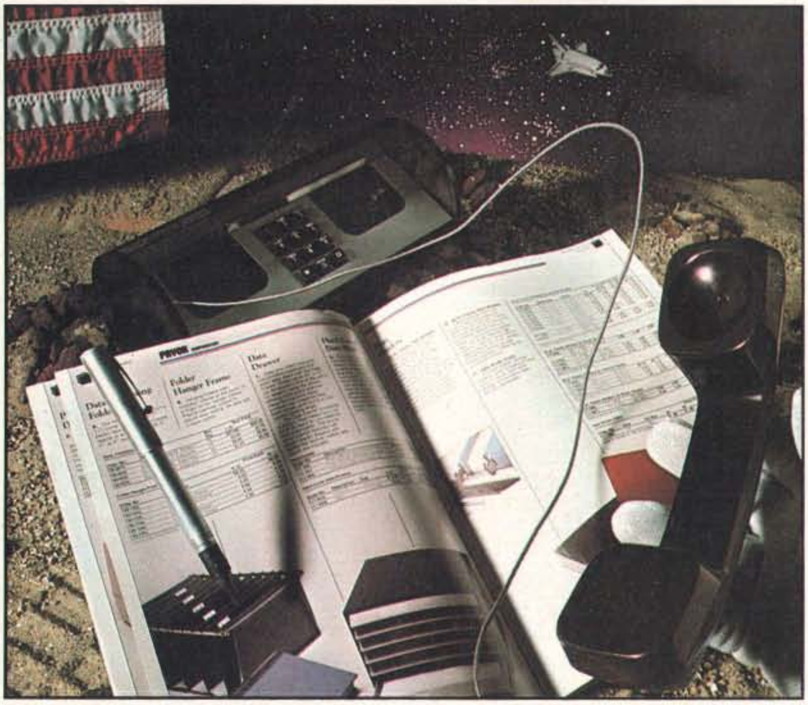

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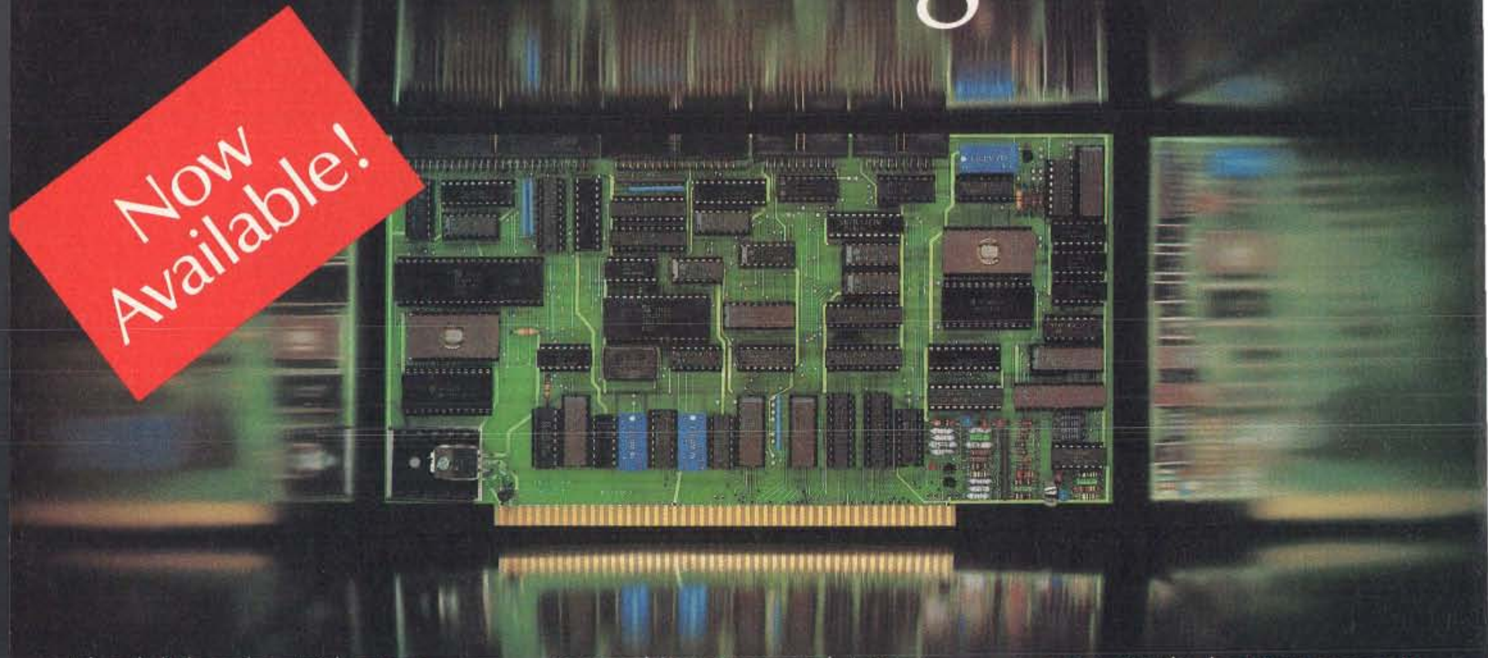

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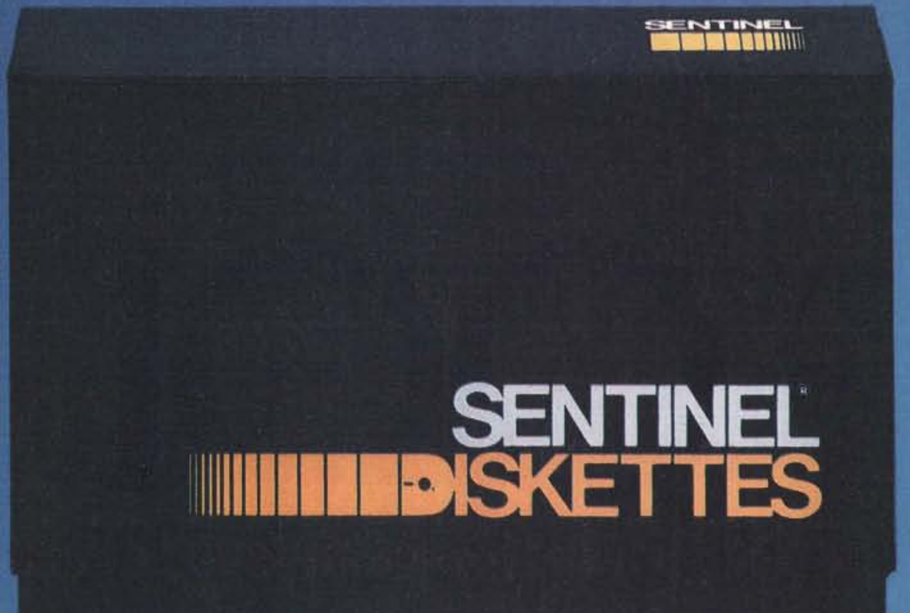

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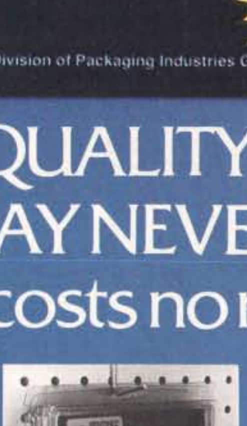

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memory with the <CLEAR><6> <CLEAR><:> command and got a couple of graphics characters printed following the receiving filename for my trouble.

Needless to say, I was extremely nonplussed, so I began to experiment with the command sequences listed in the remainder of the instructions, only to be rewarded with open files, empty files, a half-hour of toll and connect charges, and one massive headache. By the time I finally deduced the nature of the problem, I was fit to be tied.

Now don't get me wrong; I love my new Model 4 and wouldn't trade it for a whole room full of other types of computers (they each have their own set of drawbacks anyway), but I do wish that companies would pay a little less attention to rushing things to the market to beat the competition and a little more attention to providing comfort and convenience to the people who are plunking down a couple of thousand dollars for the companies products.

Tom Greenwell
2017 East Walnut Ave.
Visalia, CA 93277

Hearing Loss and CRTs

Like reader Page (Letters, October, page 30), I am bothered by the high-frequency audio output of monitors and televisions. This has kept me from watching TV (not such a bad thing) but also has caused me trouble when using my computer.

My solution was to build a plywood box with a glass front for the monitor. The glass is clamped down on foam-tape weather stripping and all the joints of the box (and the cord hole) are sealed with silicone RTV. As the glass is tightened down on the foam tape and the final leaks are closed, the squeal goes away. Of course, the monitor runs hotter than before, and I turn it off during breaks. The monitor has worked fine for two years in the box.

I suggest that the box be sized generously to allow internal air flow and that its exterior not be covered with papers, etc. To control high-frequency sound it is necessary to get it as airtight as possible.

I note that all the current research into health problems from VDTs (video-display terminals) has ignored this problem and suggest it as a good topic for re-

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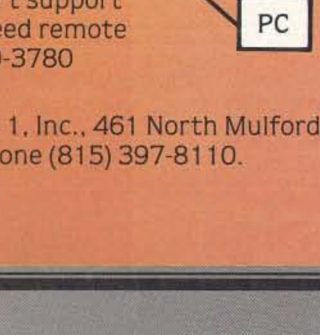

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search. Perhaps the reason it has been ignored is that our society of TV watchers has acquired a notch in its hearing at the critical frequency. An interesting question is where in the hearing system the notch occurs.

Another question that seems to get little attention in the current VDT studies is the effect of screen flicker with short-persistence phosphor screens and/or poor drive circuitry that doesn't keep the characters still on the screen.

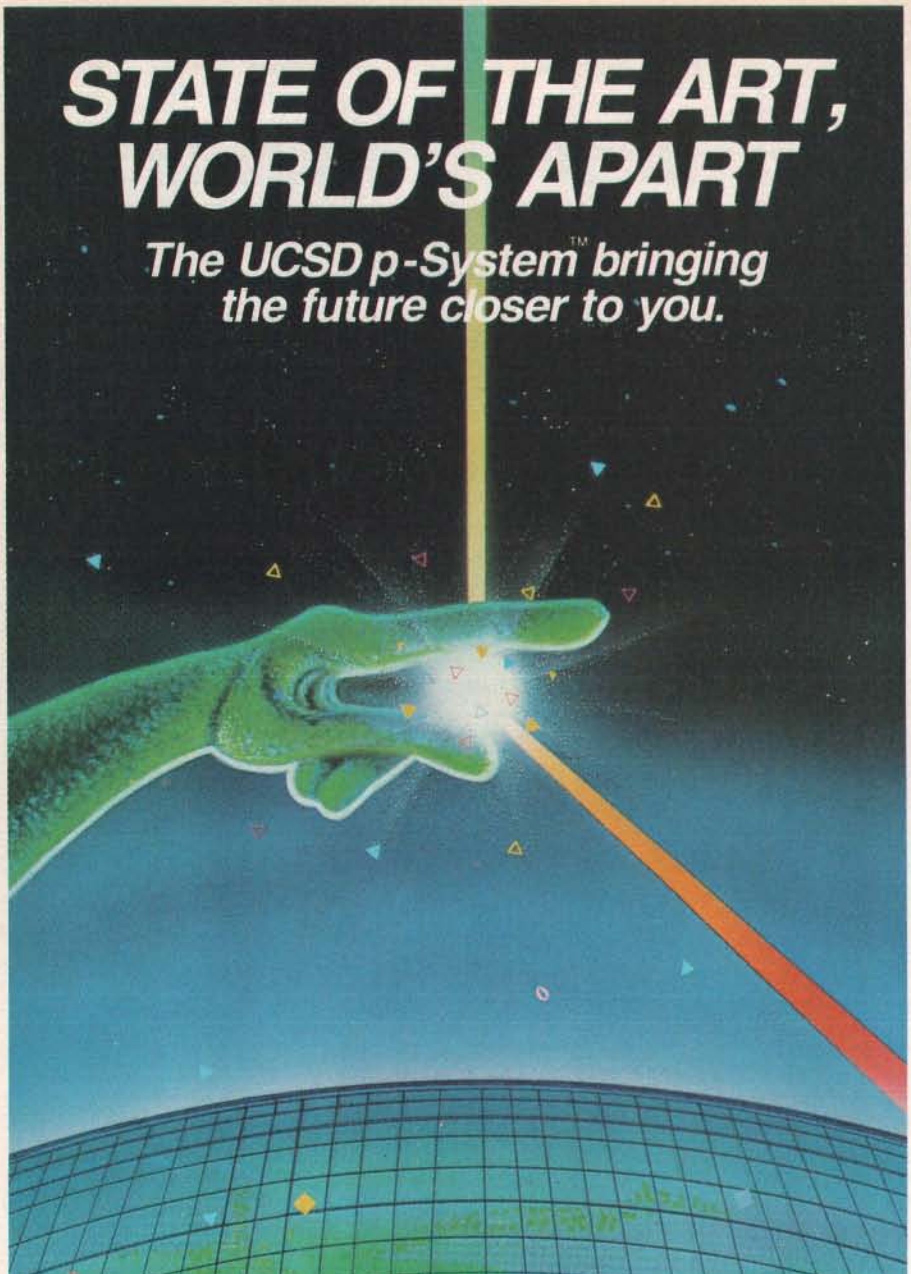
Doug Milliken
245 Brompton Rd.
Williamsville, NY 14221

Regarding the letter from Reverend John Page—this high-frequency noise is a ubiquitous phenomenon caused, I believe, by the fact that the monitors are designed by deaf engineers. Most men have lost their hearing at 15.7 kHz by their early twenties and thus build and design the monitors with cheap flyback transformers that vibrate at the flyback frequency. The medical problem is thus with the engineers and not with those who can hear those frequencies. Measurements near the cooling holes of many monitors give readings as high as 90 dB (decibels).

I have also been trying to find a monitor without this defect. I am going to try wrapping the flyback transformer completely, which will require rewiring it to the board so the wrapping can go under it as well. However, a better course would be to put pressure on the manufacturers to build better equipment.

William G. Unruh
Department of Physics
University of British Columbia
Vancouver, B.C.
Canada V6T 2A6

I believe that John Page has identified a problem with CRTs (cathode-ray tubes) that may be of much more immediate concern than the recent controversy about CRT radiation hazards. I, too, have experienced ringing in the ears and headaches after extended sessions at the keyboard, two feet away from a monitor that, as most do, puts out a 15-kHz squeal from its horizontal oscillator. An informal poll of several friends reveals that about half of them have experienced the same symptoms or worse, but these were attributed to fatigue. It would appear that the difficulties mentioned by Mr. Page are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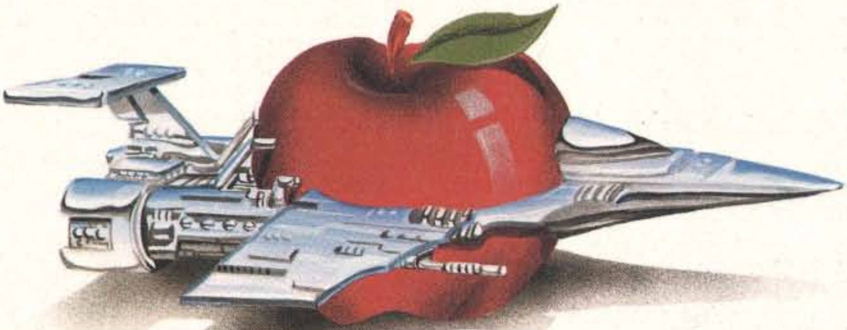

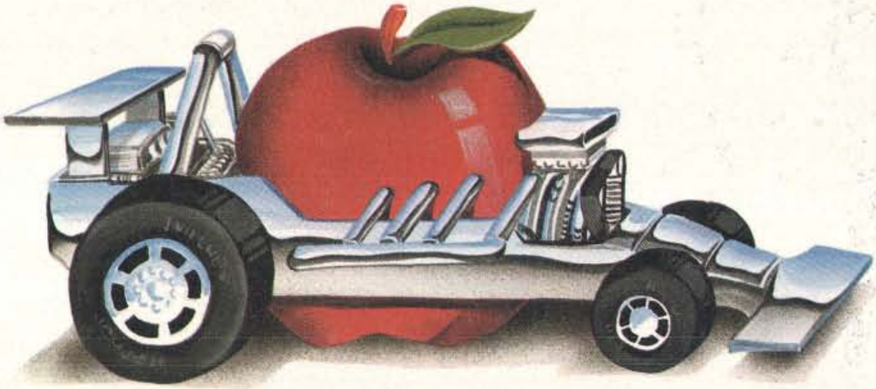

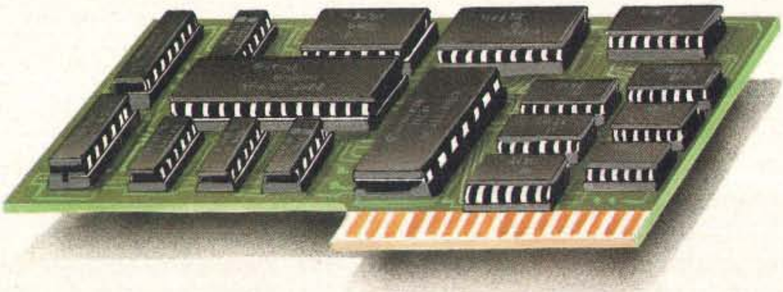

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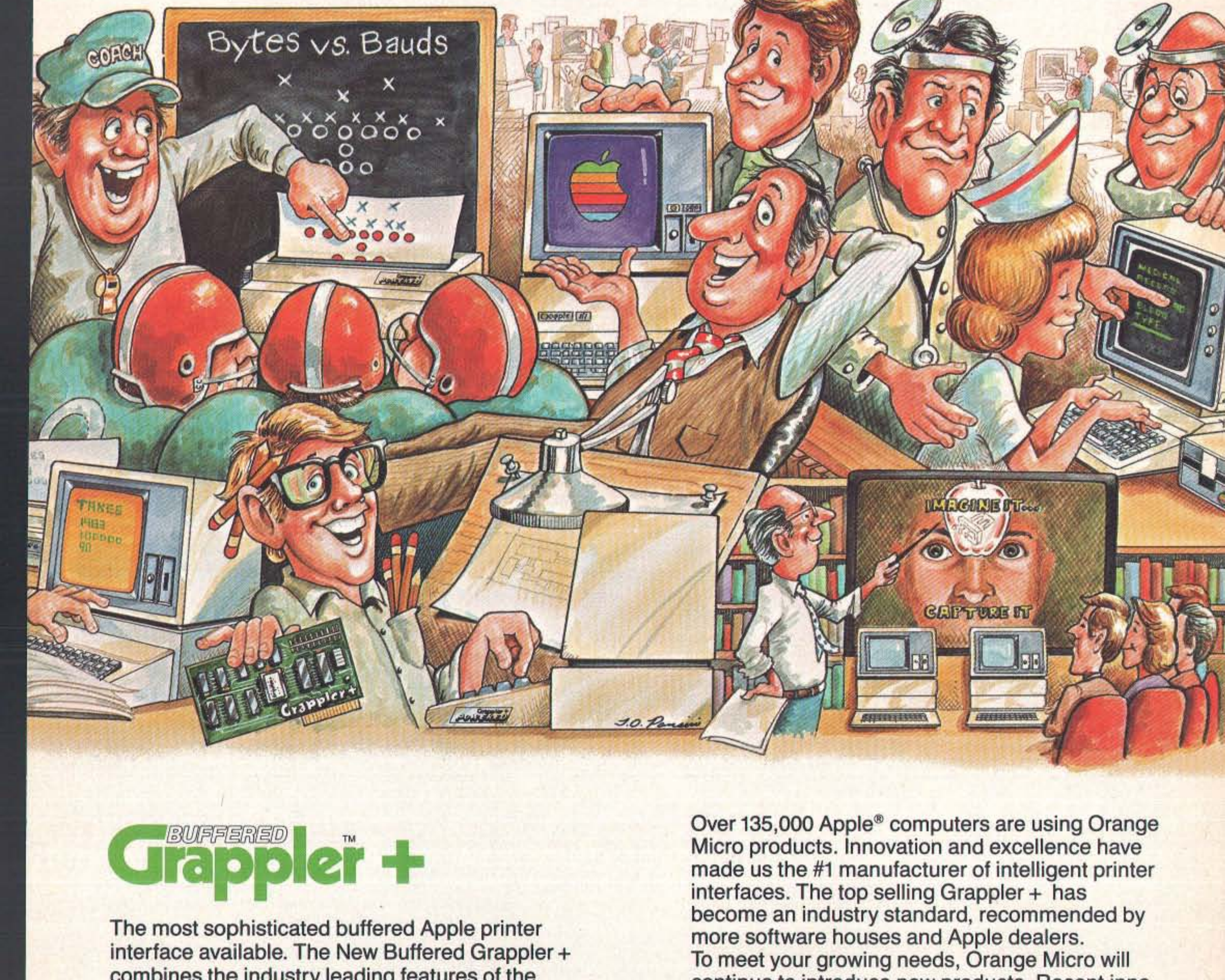

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not limited to individuals with special inner-ear problems but are instead suffered by many of us to a greater or lesser degree.

This same phenomenon is discussed in greater detail in a letter to *Softalk* (October Open Discussion, page 43) from J. Barry Smith of Massachusetts, a professional audiologist who was able to measure 15-kHz sound-pressure levels as high as 44 dB at the operator's ear. I think this problem may be widespread, especially among the female population of computer operators, who typically have more acute hearing than men.

I have no direct answer for John Page in his search for a silent terminal. I think he has identified a problem that we all may share, and I hope if an answer exists that it will be given widespread publication.

Gary Keene
5 Tangerine
Irvine, CA 92714

Model 100 Flaws

In Mahlon Kelly's informative (and justly enthusiastic) article about the Radio Shack Model 100 ("The Radio Shack TRS-80 Model 100," September, page 139), a problem is presented and left unsolved: because the editor will not let you back into BASIC with an ill-formed text, Mr. Kelly points out on page 156, "It's possible to make the edited program so screwed up that you can't find the error and you can't even get out by hitting the Reset button." Because turning the power off and on will simply bring you back to the same point, the problem can be annoying indeed.

The solution is this: use function keys F7 and F6 to cut the whole program, putting it into the paste buffer. Then press F8 to get into BASIC with what is now a null program. Then you can simply paste the whole thing in, and BASIC will not only accept it but obligingly flag all your syntax errors.

There is another problem that Kelly doesn't mention. If you want to upload a file through TELCOM but press the download function key by mistake, as soon as you name the file that you expect to be transferred, that file will be wiped out to make room for what the Model 100 expects to receive. There is no fix, but my solution (because I can never remember which is up and which is down) is to write "Hither" and "Thither" in ink under the relevant function keys.

Ronald de Sousa
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University of Toronto
Toronto, Ontario
Canada M5S 1A1

Support for Modula-2

I was very interested to read in your August issue about new releases of Modula-2 ("The Debate Goes On. . ." by Jerry Pournelle, August, page 312). I have been using Modula-2, with increasing enthusiasm, for several years now, using Professor Wirth's E.T.H. compiler, and feel that Modula-2 will most likely become the successor to Pascal, because of its elegant and straightforward solution of so many of Pascal's problems. However, this will really depend on a number of commercial implementations of Modula-2 becoming available, with the backup and support that this implies, rather than with the responsibility resting on the user to sort out any problems that arise. In many respects the situation is like Unix three

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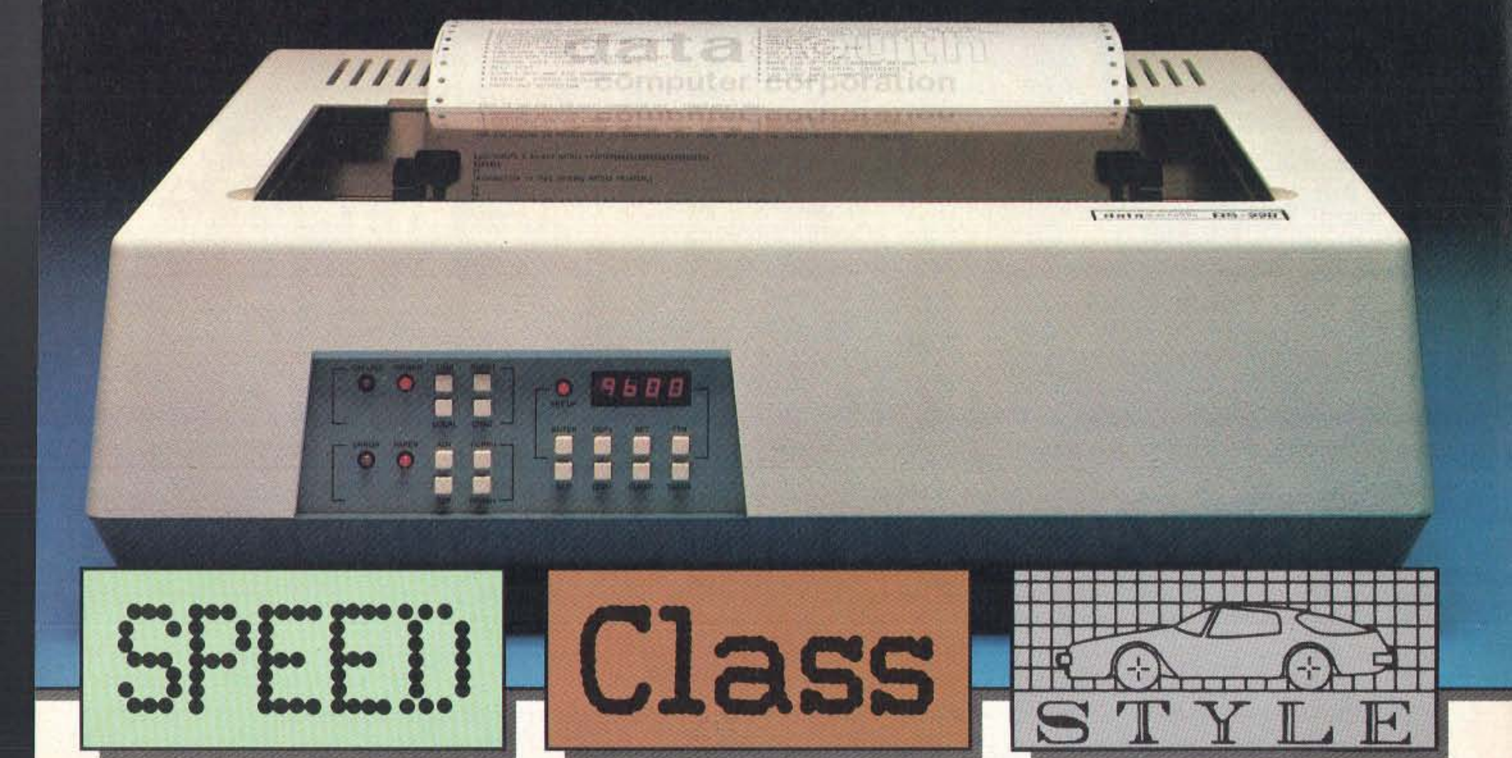

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years ago, and sufficient commercial support could so easily make Modula-2 the standard language for many real-time microcomputer applications, in the same way that it has established Unix.

H. W. Thomas
Electrical Engineering Laboratories
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The Future of Programming Languages

As a professional programmer and longtime user of the C programming language, I am very happy to see the increased interest in this area. Also, as the teacher of a beginning C programming course organized through AnaHUG, a local computer club, I was grateful for James Joyce's excellent introduction to the language ("A C Language Primer," August, page 64, and September, page 289). However, I would like to correct one statement in Part 1 of the series that could confuse the novice C programmer. While discussing the `printf( )` function, Mr. Joyce states, "All arguments of a function must be on the same line in C." He then adds, ". . .the entire string in `printf` must be on the same line." This is a contradiction to *The C Programming Language* by Kernighan and Ritchie, which states (on page 179) that in C source code, "Blanks, tabs, newlines, and comments (collectively, white space). . .are ignored except as they serve to separate tokens." In addition, that text states (on page 181) that, "[In a string] a \ and an immediately following newline are ignored." It has been my experience that Unix C compilers follow *The C Programming Language* in this respect. For example, using Unix C compilers I have used `printf` function calls of the form

```
printf
("This is an example of a format
string \ split across a line. Numbers
follow: %d %d %d",
  5*75,
  7*7,
  99-83);
```

Note that in this example the format string is split across a line (the second line must be left-justified or the extra spaces will appear in the printed output), and the additional arguments are on separate lines (which might allow comments following each).

John F. Belsher
Custom Programming
1283 San Paulo
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BYTE's Bugs

Insert GOTO

William N. Carter of San Francisco raised the point that the program by Ed Juge in Mahlon Kelly's "The Radio Shack TRS-80 Model 100" (September, page 139) needs a correction. Line 140 calls for GOSUB 360; that subroutine lacks a RETURN. The program will work just fine if you change it to a GOTO 360, move the PR$=L$ to the second statement in line 60, and delete line 160.■

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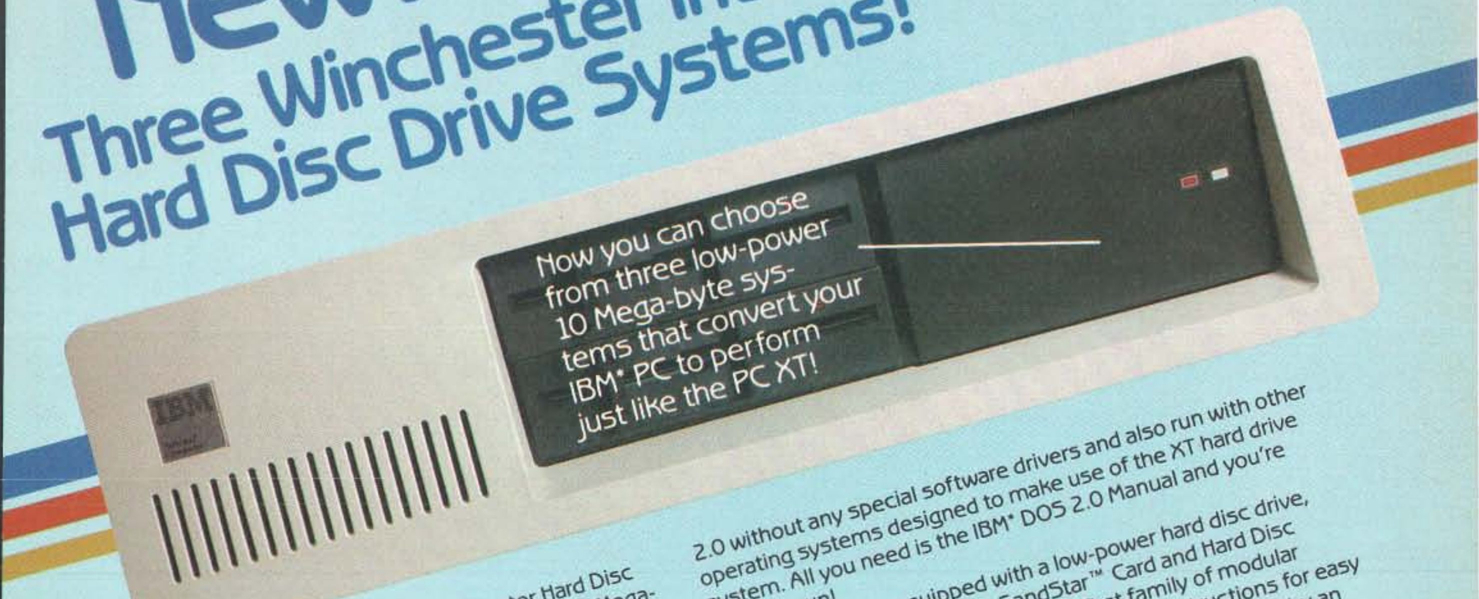
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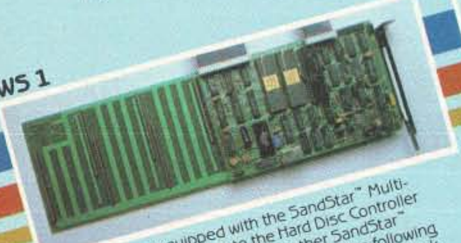
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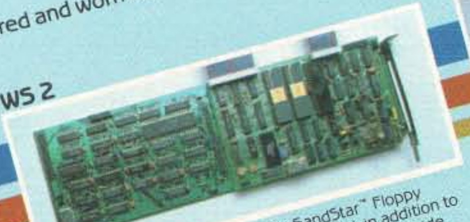
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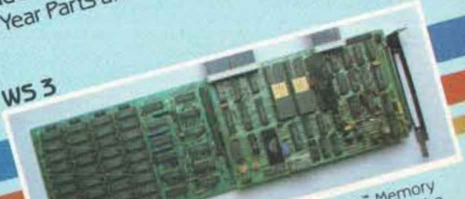
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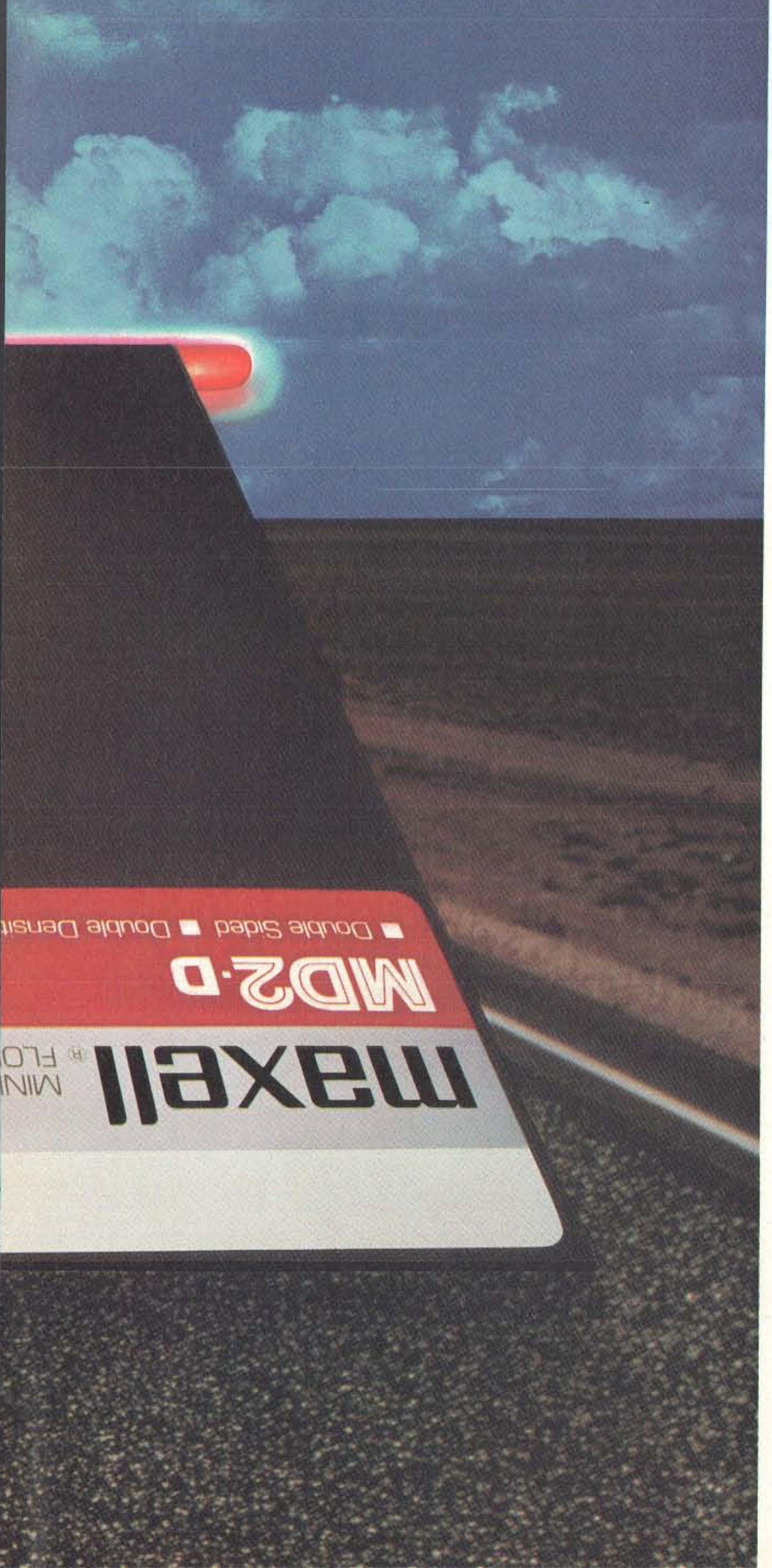

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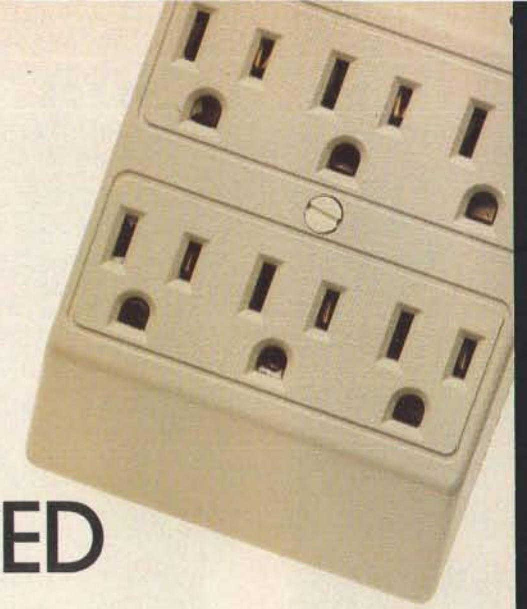

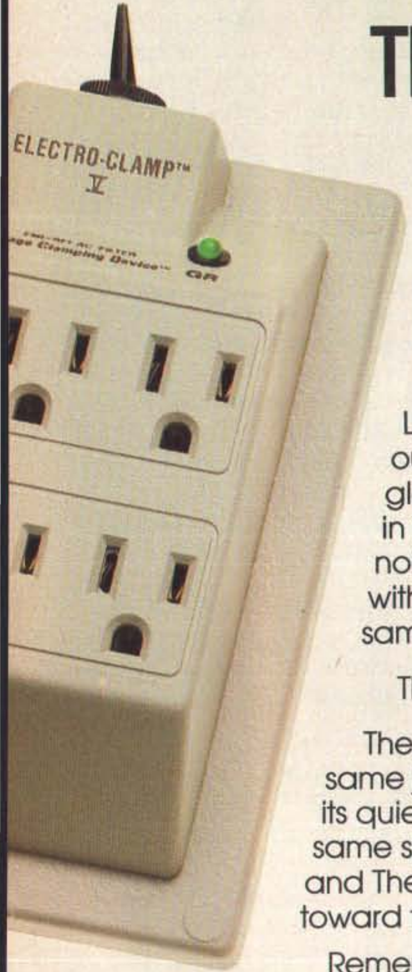

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Build the Circuit Cellar Term-Mite ST Smart Terminal

Part 1: Hardware

National Semiconductor's NS455A Terminal-Management Processor permits an easy, economical terminal design

by Steve Ciarcia

Did the the personal computer revolution begin in 1975 with the MITS Altair 8800 microcomputer? Most people think so, but I believe that the first personal computer product appeared two years earlier under the unassuming name of TV Typewriter. This construction project, described by Don Lancaster in *Radio Electronics* magazine (see reference 6) was a simple video-display terminal, a basic building block for those of us who were dreaming about building a computer. The circuit logic was a wiring nightmare of controlled race conditions, but it worked. Of course, its uppercase-only 16-line by 64-column display and total ignorance of control codes (it didn't even scroll) seem primitive today.

A few months after Don's article was published, the Mark 8 computer project appeared in *Radio Electronics* (see reference 10). The Mark 8, based on the Intel 8008 microprocessor, was the first real microcomputer (though the word had not yet been coined) and was the trigger that launched me and many others into the microcomputer hobby. Many of us who had built Don's terminal might not have been otherwise able to comprehend and use the Mark 8 as quickly as we did. (I built something different from the Mark 8, but the first article I ever wrote was for the Mark 8 constructor's newsletter. Coincidentally, my first BYTE article described how to build a vector-graphics display for an 8008-based system—see reference 2.)

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Advancing Display Technology

Wiring up the TV Typewriter was a monumental job, but the basic circuit was really not unlike a commercial video-display terminal of the same period. If you ever opened the case of a video terminal from the early 1970s, you were probably amazed at the complexity. There were usually several large printed-circuit boards (each containing 70 to 100 integrated circuits), a large power supply, the keyboard, wires and diodes, and of course the cathode-ray tube (CRT) replete with high-voltage wires and "Danger—Do Not Touch" signs.

These early terminals were basically "glass Teletypes," performing only simple functions and displaying only uppercase characters. The lack of sophistication matched the level of integrated-circuit (IC) technology available at the time.

Many discrete logic circuits were needed to detect even the simplest functions such as linefeed and cursor-home. Each command was treated independently by the hardware: it was necessary to have separate circuitry to detect each control character and cause the appropriate function to occur. For instance, for the terminal to respond correctly to the ASCII (American National Standard Code for Information Interchange) Return character, the terminal-control logic had to be able to detect when a hexadecimal 0D value was received from the host computer or typed on the keyboard, to change the current cursor position to the beginning of the line, and possibly to scroll the screen up one line (if automatic linefeed is on) and blank the new line. Connecting sets of NAND and NOR gates to accomplish this is a considerable task.

For a long time, advances in IC technology were met by demands for increased performance in terminals. The first real simplifying breakthrough came with the microprocessor. Using the power of this new development, designers could implement features that had been prohibitively expensive and could freely add new functions to terminals. Off-line editing with character insertion and deletion, function keys with multiple-character transmission, and multiple-page display memories were just a few of the features that found their way into the terminal marketplace. And as microprocessors became more advanced, terminals incorporating the latest silicon intelligence could no longer be called "dumb." The watchword in the terminal trade became *smart*.

Somewhat surprisingly, the first microprocessor-based intelligent terminals were no less complicated inside than the dumb variety. Computer circuitry had replaced much of the discrete logic, but the expanded functions had also necessitated increased complexity in the low-level display-driver circuitry. An integrated

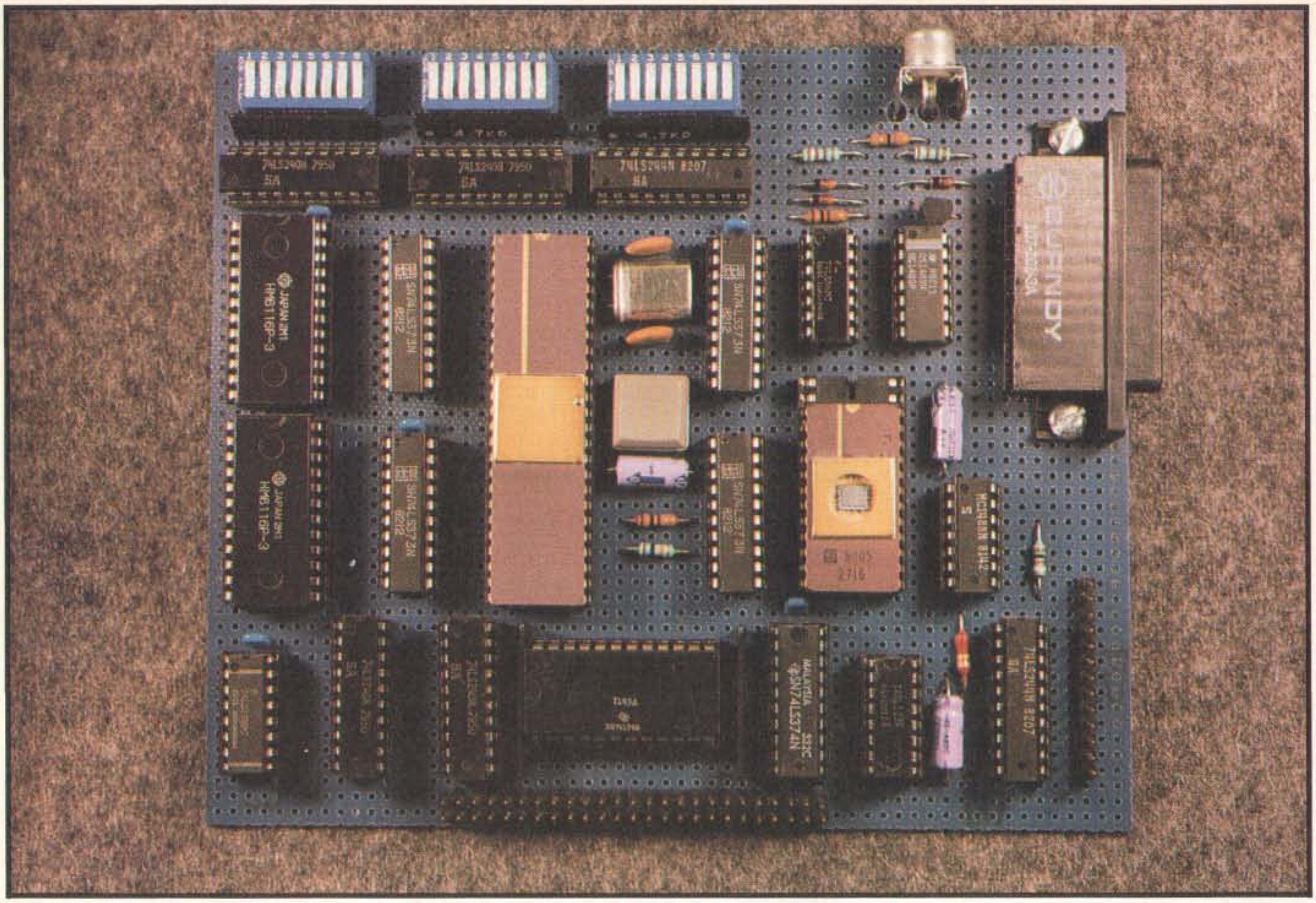


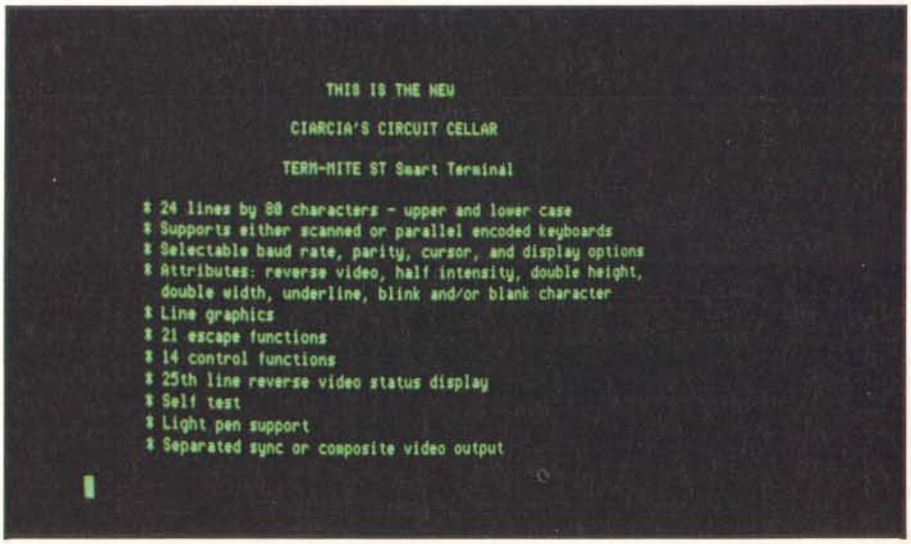
Photo 1: *The prototype board of the Term-Mite ST intelligent video-display terminal.*

solution to discrete video circuitry was needed.

The second technological achievement resulting in lower circuit complexity was the development of integrated CRT-controller (or video-controller) chips, such as the National Semiconductor DP8350 and the Intel 8275. Usually used in combination with a microprocessor, programmable CRT controllers incorporate many of the discrete counters, registers, and character-attribute circuits needed in a modern terminal. (See references 5 and 9.)

The new controller chips made it easy to do tricks with character attributes: blinking, blanked, or underlined characters; half-intensity or reverse video; and expansion to double height, double width, or both. Also, a terminal manufacturer could now easily make a whole family of terminals just by changing the control firmware. Either a simple "glass Teletype" model or a sophisticated editing terminal with write-protected fields and multiple display pages could be built with only minor hardware differences simply by changing the programs controlling the microprocessors. Figure 1 on pages 40 and 41 should give you an idea of how the combination of the microprocessor and the video-controller chip served to make hardware design much simpler while again increasing the terminals' sophistication.

For a long time now I've wanted to present a smart-terminal project from the Circuit Cellar, but even with the reduced circuit complexity afforded by a CRT controller I've never been



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     double width, underline, blink and/or blank character
   * Line graphics
   * 21 escape functions
   * 14 control functions
   * 25th line reverse video status display
   * Self test
   * Light pen support
   * Separated sync or composite video output
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Photo 2: *Unretouched photo of the Term-Mite's screen.*

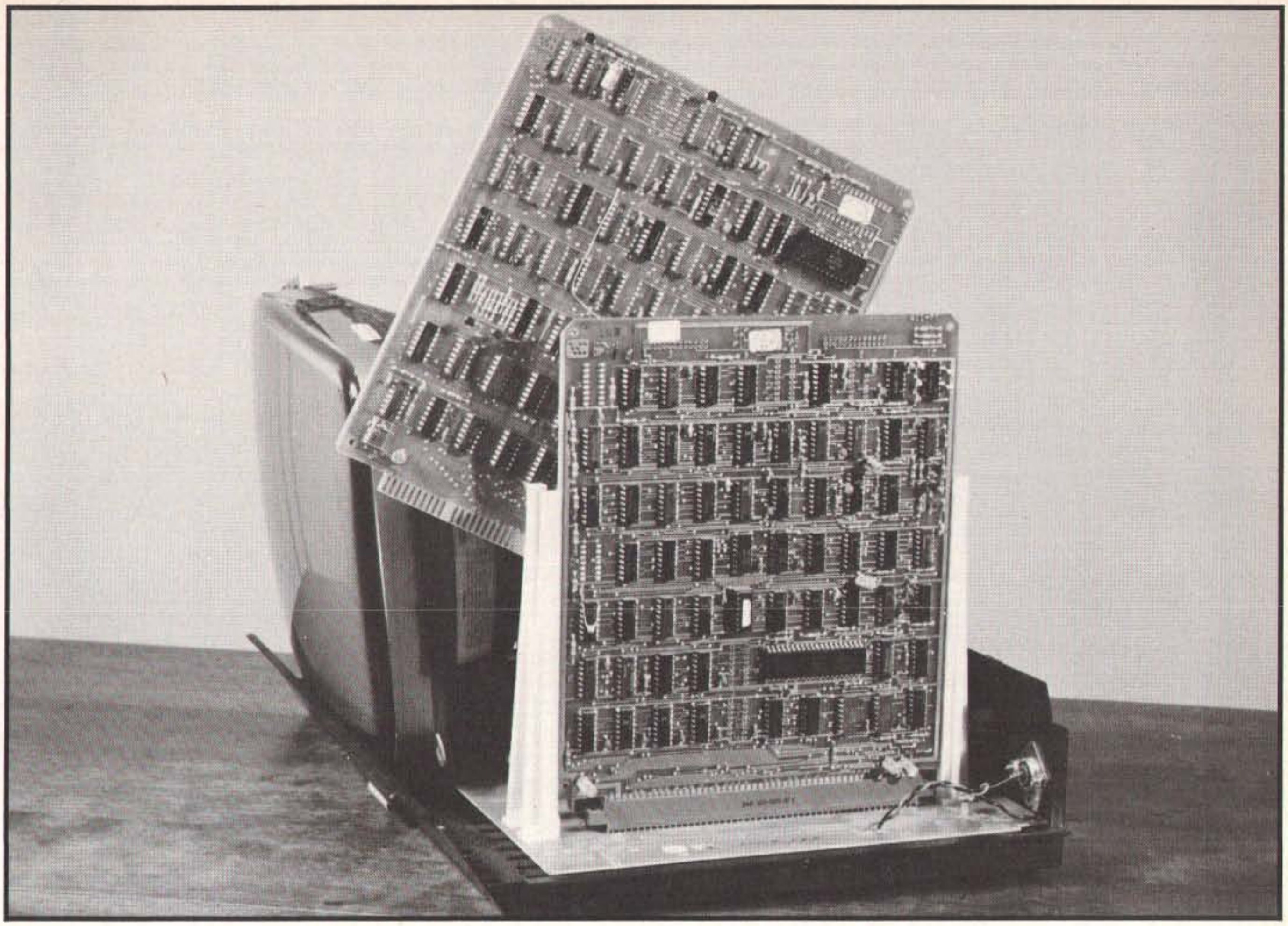


Photo 3: *Video terminals designed only a few years ago had to use over 100 discrete-logic circuits to obtain even rudimentary control functions.*

able to devise a reasonable design containing fewer than about 30 IC packages. (Yes, the MPX-16 computer I began in November 1982 does contain 121 chips, but my battle scars from that project still pain me at times.) While I was still deliberating, developments in technology caught up with me.

Semiconductor makers had provided both crucial elements: the microprocessor and the CRT controller. The next logical step was to incorporate their functions into a single IC package. National Semiconductor Corporation has done just that, and more, with the NS455A *Terminal-Management Processor* (TMP). Incorporating most of the processor, video, and communication functions in a single 48-pin dual-inline package, the NS455A allows the design engineer to reduce a terminal's chip count while maintaining a high level of performance. Just six chips can perform the basic operations.

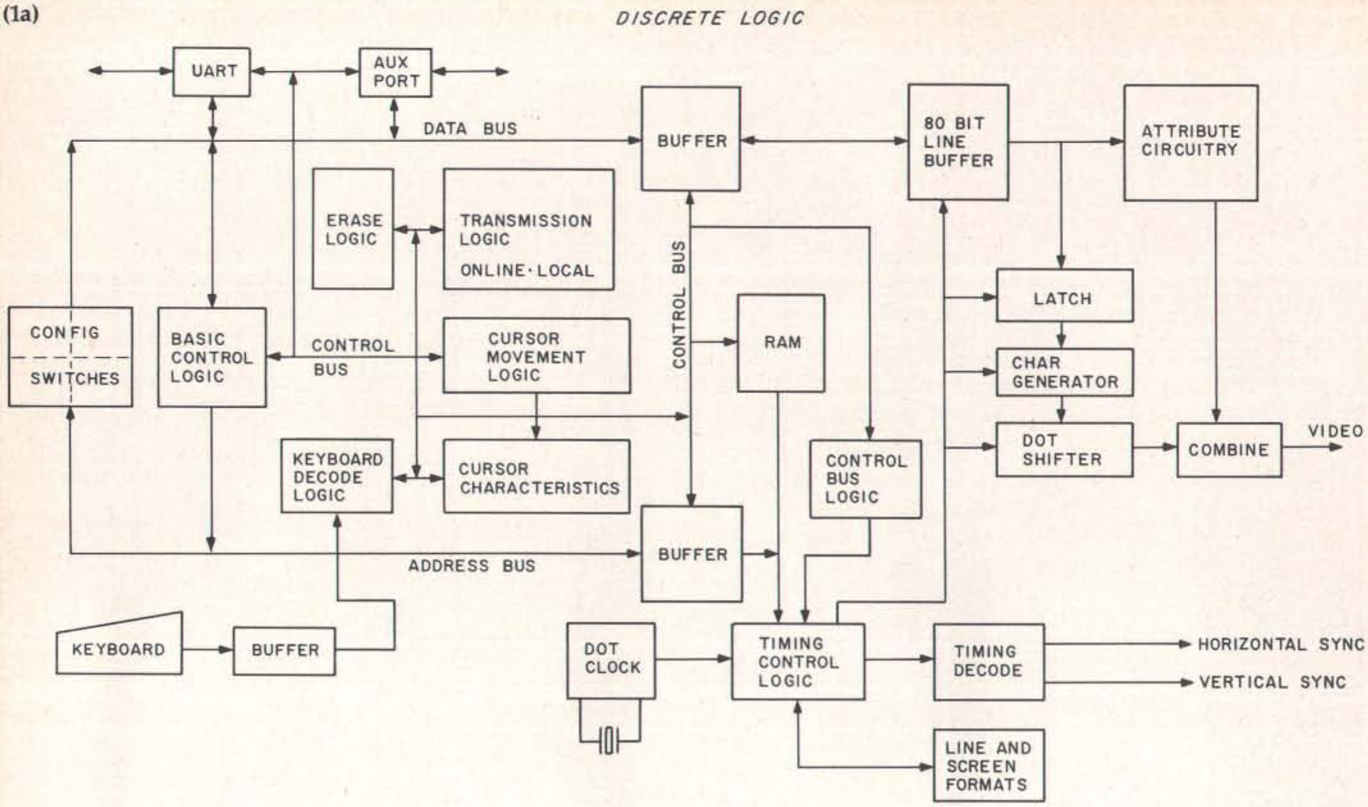
In two articles, this month and next, we'll look at the NS455A's characteristics and see how to build an intelligent video terminal, called the Term-Mite ST, which is equal to many on the market costing $1000 or more. Its 21-chip design provides the most-needed features, as shown in table 1, such as 24 lines of 80 characters each, uppercase and lowercase; a full set of character attributes; and line (block) graphics. A block diagram of the Term-Mite ST terminal appears in figure 2.

Inside the NS455A TMP

Integrated into the NS455A TMP are all the system-control functions except the video RAM (the random-access read/write memory used to store the display data) and I/O (input/output) buffers. The TMP replaces the separate microprocessor, program ROM (read-only memory), CRT controller, DMA (direct memory access) logic, character generator, UART (universal asynchronous receiver/transmitter), and data-rate generator typically used in other terminal designs. In place of these, the TMP provides a control processor, display-timing control circuitry, and direct interface logic for the keyboard, monitor, memory, and serial communication.

A complete listing of the NS455A's capabilities is shown in table 2, while figure 3 on page 43 shows a pinout diagram (3a) and a block diagram (3b). The architecture and instruction set for the TMP are derived, with some differences, from that of the Intel 8048-series of microprocessors. Extra instructions have been added and the architecture tailored to allow the NS455A to serve more efficiently as a terminal controller. Within the TMP are three distinct functional sections: processor, I/O, and display

(1a)



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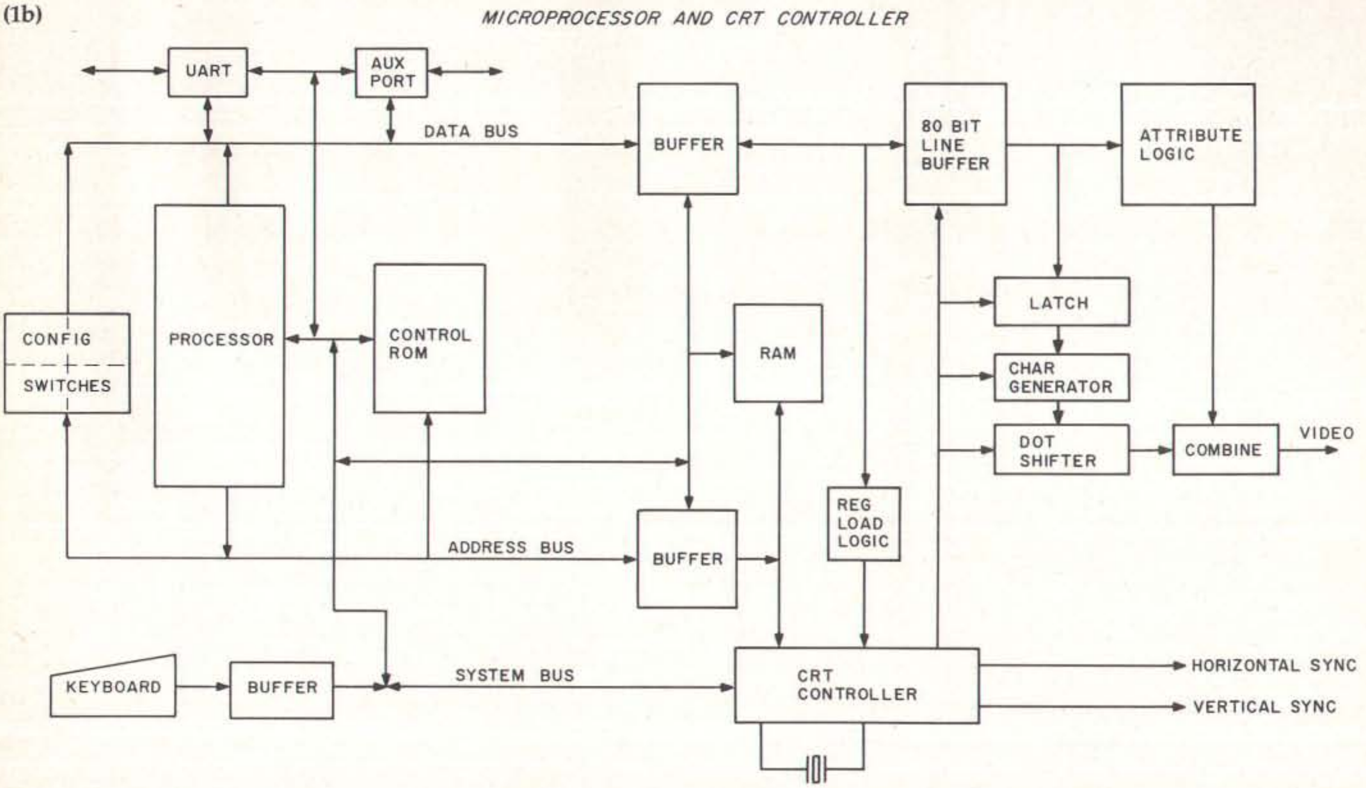


driver. Let's look at each of these in turn.

Processor and Memory

Since the processor in the TMP is a modified implementation of the Intel 8048 architecture, I'll review the 8048 to make comparison easier.

The basic 8048 was designed as a self-contained microprocessor; it includes ROM for its factory-set permanent program as well as temporary storage in the form of scratch-pad RAM. It operates on 8-bit data but has an 11-bit program-counter (PC) register, so that it can address up to 2K bytes of program. The standard 8048 has an eight-entry fixed-size

(1c)

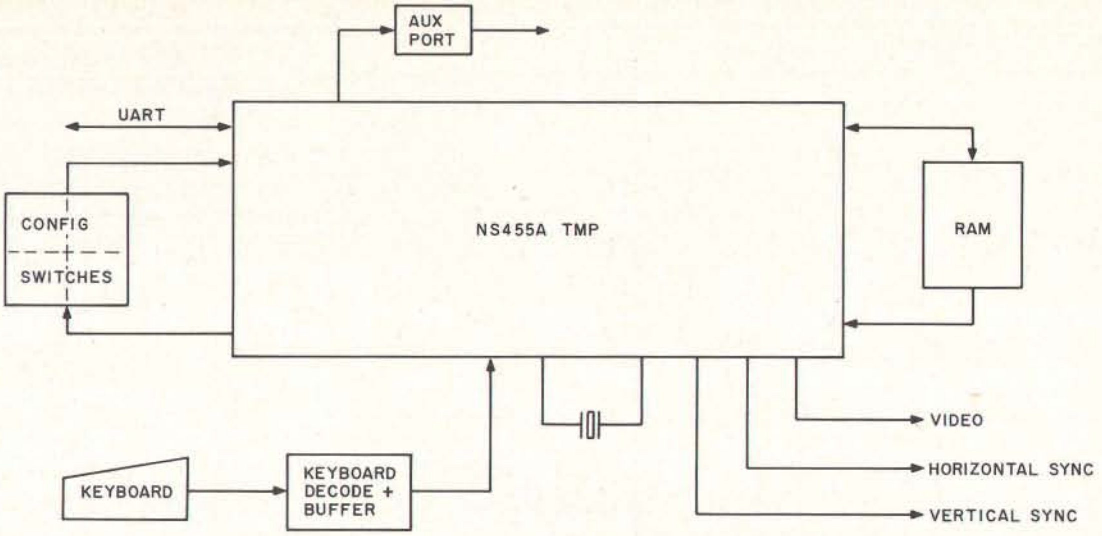


Figure 1: *Three generations of video-display terminals become increasingly less complex as semiconductor technology advances.*

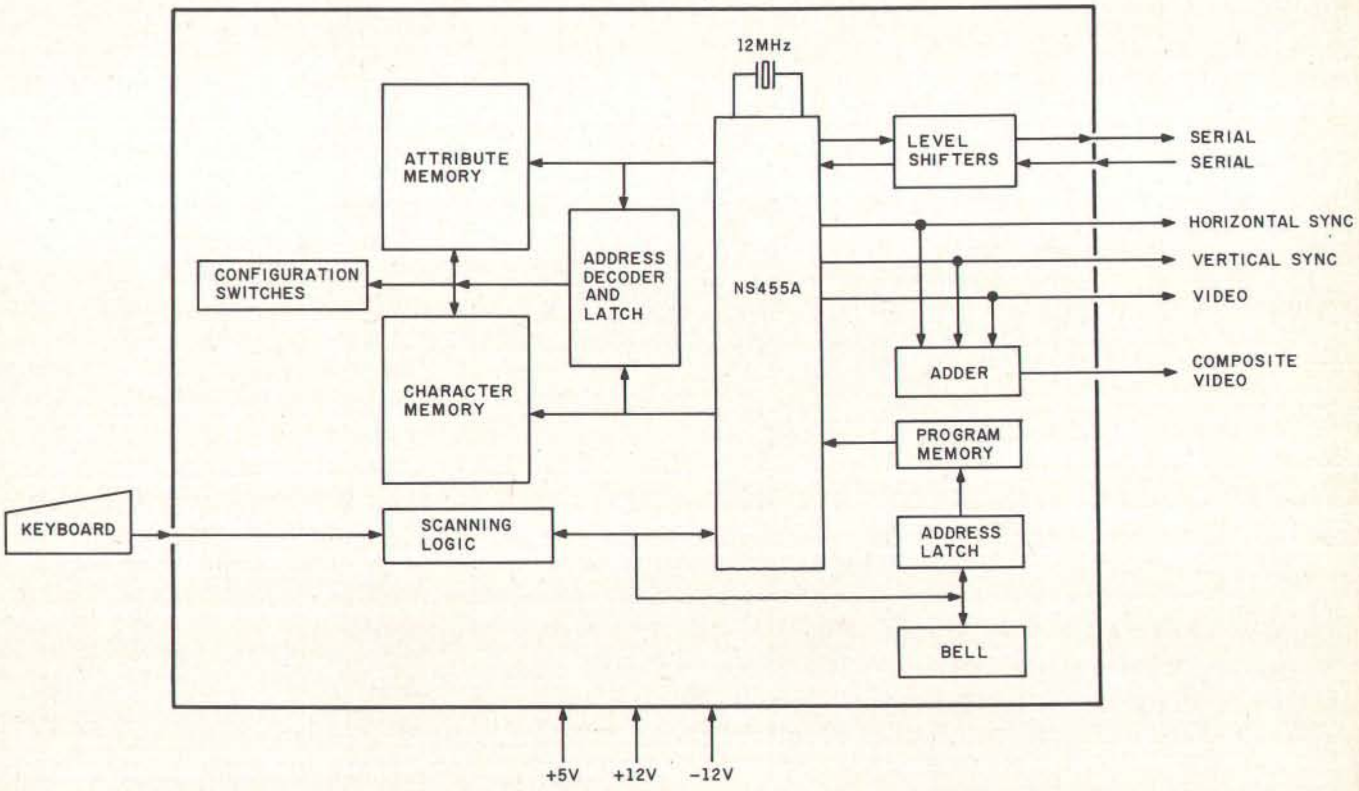


Figure 2: *A block diagram of the Term-Mite ST terminal circuit board.*

stack used to store return addresses during subroutine calls and interrupt handling; the stack pointer consists of 3 reserved bits in the processor status word (PSW). A set of general registers in the RAM, R0 through R7, can be used for fast-access storage. In addition, an alternate register bank, also located in the on-chip RAM area, can be selected and used just like the primary set. Finally, the standard 8048 has three parallel I/O ports, which can be used to communicate with external peripherals or to address additional memory. (I used the 8748, a cousin of the 8048, in my recent H-Com project; see reference 3.)

When National Semiconductor en-

1. 24 lines by 80 characters, uppercase and lowercase
2. supports either scanned or parallel-encoded keyboards
3. selectable data-rate, parity, cursor, and display options
4. attributes: reverse video, half intensity, double height, double width, underlined, blinking, and/or blank character
5. 21 Escape functions
6. 14 Control functions
7. line (block) graphics
8. twenty-fifth-line reverse-video status display
9. self-test
10. separate-sync or composite-video output

Table 1: *Features of the Term-Mite ST terminal.*

1. enhanced 8048 instruction set and architecture
2. on-board ROM, 2K by 8-bit; up to 8K by 8-bit external
3. on-board RAM, 64 by 8-bit
4. programmable display format
5. 16-bit display-memory bus (direct-video and attribute-RAM interface)
6. built-in timer
7. real-time clock (may be programmed for 1 Hz)
8. video-control signals
9. eight independent character attributes
10. pixel graphics
11. programmable cursor
12. CRT refresh at 50 or 60 Hz
13. light-pen support
14. on-board UART, programmable data rate up to 19,200 bps
15. character generator (128 characters in 7- by 11-dot character area)
16. single +5-V (volt) supply
17. interface compatibility with popular 8- and 16-bit microprocessors
18. up to 18-MHz clock frequency
19. 48-pin package
20. 8-bit parallel port (multiplexed with external ROM)

Table 2: *Features of the National Semiconductor NS455A Terminal-Management Processor. This integrated circuit normally comes with a terminal-control program mask-programmed into the 2K bytes of on-board ROM.*

hanced the architecture for use in the Terminal-Management Processor, instructions that manipulate 16-bit data were added, so that the TMP could manage up to 64K bytes of display memory. To support these instructions, an 8-bit high-order extension, called the *high accumulator,* was added to the existing 8-bit accumulator. In addition, 8-bit high-order extensions were added to the R0 and R1 registers to allow them to point to the full 64K bytes of display RAM. The original roster of three I/O ports was trimmed to a single bidirectional port, and 2 more bits were added to the program counter to accommodate up to 8K bytes of program storage.

All the other changes from the 8048 processor were directly associated with the additional tasks of video-display driving and I/O required to do the job. Display-management registers were added to help with the screen-refresh chores. A cursor register serves to load characters into the display RAM as well as to mark the current cursor position. A whole set of video-timing-chain registers is used to set the display configuration for the screen: how many characters per line, how many lines per frame, horizontal and vertical synchronization timing, etc.

While the characters to be displayed are stored in RAM, the program that drives the NS455A's processor resides in ROM. The NS455A may operate with either internal or external ROM; external ROM may function all by itself (disregarding the internal ROM), or it may supplement the internal program. Although address space is provided for up to 8K bytes of program, the standard on-chip ROM size is only 2K bytes. The off-the-shelf NS455A TMP comes with a standard program, masked into the 2K-byte ROM, which is intended to illustrate the capabilities of the chip and serve as a tutorial example of terminal programming.

I/O-Port Section

The single I/O port is an 8-bit bidirectional parallel type, with data transferred on pins RE0 through RE7. It is written into and read from using the processor instructions OUT PORT and IN PORT. In the Term-Mite ST, the encoded keyboard is read and the RS-232C handshaking-protocol signals (Data Terminal Ready, Clear to Send, and Ready to Send) are transmitted through this port. The keyboard uses only 7 bits, so a signal to sound the terminal's "bell" beeper is sent out on the extra bit.

The serial input and output functions are handled by the on-chip UART through the serial-in line and serial-out line. The UART also contains the data-rate generator, which can be set up by software for virtually any data rate. The standard program, however, contains only the set of 12 most-used rates from 110 to 19,200 bps (bits per second). The serial I/O lines need only to be buffered by level-shifting devices (the MC1488 and MC1489) to give you a complete RS-232C data path to a host computer or other data-communicating device.

Display-Driver Section

The third section is the video-display driver and control section. It is made up of the character generator, the CRT-refresh logic, the character-attribute logic, and many now-integrated, formerly discrete functions. Because the NS455A provides all these capabilities by itself, the only additional ICs needed are display

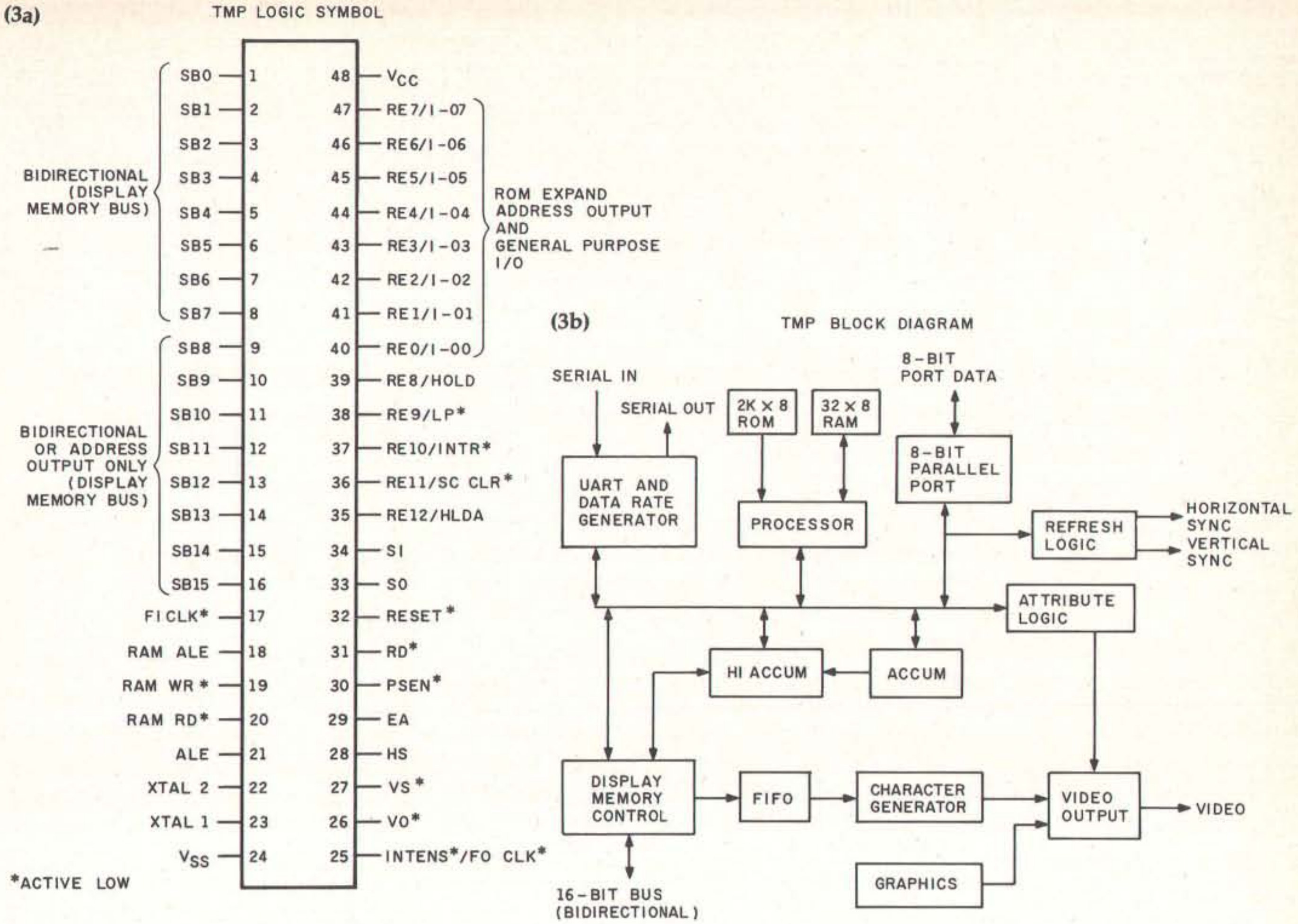


Figure 3: *A pinout diagram (3a) and a block diagram (3b) of the National Semiconductor NS455A TMP.*

memory, an RS-232C buffer and a driver, and a bus-interface latch or two. In fact, an absolutely minimal video terminal could be constructed from 6 chips, and a relatively high-performance unit could be built from only 15.

You may not be as familiar with the complex workings of the CRT driver and control section as with the other two preceding sections. Indeed, because the screen image must be refreshed 60 times every second, the video circuitry stays very busy. The best way to see what happens is to follow a character from display memory until it appears on the screen.

First, the character is read by the display-access logic from the display RAM into the FIFO buffer (a small first-in, first-out storage area). The FIFO buffer contains only four entries, but it is needed so that the processor and display-refresh logic, which both require continual access to the RAM, will not contend with each other for that access.

(The refresh logic has to push characters through the analog video section at a constant rate; if the refreshing is delayed, the display will flicker where characters or parts of the image are being missed. In older designs using CRT-controller chips, the usual technique was to allow the processor to run only during the horizontal and vertical retrace times of the electron beam—barely 40 percent of the time. Such approaches, once considered necessary, can severely limit throughput; you can recognize the terminals that employ this scheme as the ones whose displays flicker when they are updated.)

A FIFO buffer solves the problem. The refresh logic can fill the buffer faster than the video logic can empty it, so when the buffer is sufficiently full, the processor is allowed to grab and use a display-memory cycle. The processor has to be held off only intermittently, and then not for very long.

As the character code leaves the FIFO buffer, the proper pattern of display dots (picture elements, or pixels) in a bit-mapped dot matrix is selected by the character generator according to the character's shape. What dot value leaves the generator at a given instant depends not only on what the character is but also the current scan line (vertical position) of the video raster. In the case of the Term-Mite ST, the character information is retrieved from the character generator's ROM, where the dot patterns are stored, using the ASCII code value as a high-order address; the scan-line position is used to set up the low-order address bits. The dots for all the characters in a scan

Strobe Number	A15	A14	A13	A12	
0	0	0	0	x	page 0 memory
1	0	0	1	x	page 1 memory
2	0	1	0	x	page 2 memory
3	0	1	1	x	page 3 memory
4	1	0	0	x	terminal-characteristics switch
5	1	0	1	x	miscellaneous-status switch
6	1	1	0	x	UART-configuration switch
7	1	1	1	0	scanned keyboard-input port
8	1	1	1	1	auxiliary/printer-output port

Table 3: *Memory-mapped I/O addressing as used in the Term-Mite ST. The final hardware of the project does not support the printer port.*

Bit	Attribute
0	reverse video
1	half intensity
2	blinking
3	double height
4	double width
5	underlined
6	blanked
7	graphics

Table 4: *Character attributes supported by the NS455A in the Term-Mite ST.*

line are assembled into a parallel field containing dark and bright dots. These dots are then serialized and shifted out to the screen, one at a time.

Information on other character attributes may be sent along with the basic black- or white-dot data. Specialized logic was incorporated in the 455A to modify the dot output according to the display attributes selected, but, generally speaking, the logical process for accomplishing this has not changed from that previously implemented by many external logic gates.

Eight special character attributes are provided by the 455A: blinking, double height, double width, graphics, half intensity, reverse video, underlined, and blanked character. A terminal built around the 455A can specify the attributes in two ways: internally or externally.

Internal attributes make use of two attribute latches (AL0 and AL1) inside the TMP chip. These latches can be read by external circuitry. Their states are determined by the most significant bit (MSB) in the character-code byte (the character set is therefore limited to the 128 standard ASCII 7-bit characters). If the MSB is a 0, AL0 is activated; if the MSB is a 1, AL1 is activated. The latch status and the incoming character dot values completely specify the final appearance of the displayed character.

When the TMP is configured for *external attributes*, a 16-bit-wide display memory is used. The lower 8 bits specify the character, and the upper 8 bits are used to handle the attribute data. Although this arrangement doubles the memory needed in the video RAM section, it gives you the freedom to use any possible combination of attributes for any character.

The remaining video logic involves the horizontal sync (synchronization) pulse and the vertical sync pulse. The horizontal sync pulse is generated by the video circuitry in the TMP, but its timing is under program control. It is the terminal designer's responsibility to decide the crystal frequency used to drive the TMP, the number of characters per line, the size of the character cell, and the tolerances of the CRT's driver circuits. In most cases, all of these variables must yield something close to 15,750 Hz (hertz) for the frequency of the horizontal sync signal; the frequency must allow the display of 80 characters per line plus enough time to permit the electron beam to retrace to the beginning of the next scan line. The vertical sync pulse will occur at either 50 or 60 Hz depending on where in the world the terminal is to be used (in North America 60 Hz would be used). The necessary programming has already been done in the standard NS455A and in my Term-Mite ST project.

A terminal built around the 455A can specify attributes in two ways: internally or externally.

Memory-Mapped I/O

Because there is only one parallel port and one serial port, I/O by conventional methods is limited in the TMP. But, fortunately, by mapping I/O registers into memory addresses, you can greatly expand the TMP's I/O capabilities. (See reference 4.) For example, a printer port could be placed at address hexadecimal F000. The processor would just act like it is putting data into a memory location at that address, but the data would actually be sent to the printer.

Technically, there are 16 bits of memory-address space, which could in theory define 64K (65,536) I/O locations. However, it's only necessary to put in circuits to decode only the 4 high-order bits to designate nine specific memory-address allocations. These are listed in table 3. As with all construction projects, I had to observe practical limits when I froze the design. Even though the NS455A can support the printer port, the Term-Mite ST as presented in this article does not incorporate it, and only eight of the nine I/O addresses are available.

Term-Mite ST Design Details

The Term-Mite ST is an intelligent video-display terminal built from 21 integrated circuits (or 18 if you use a parallel-encoded keyboard). Shown in the schematic diagram of figure 4 on page 46, the circuit is intended to operate with the same ordinary 2K-byte terminal-control program mask-programmed into the generic NS455A but contained instead in a 2K-byte type-2716 EPROM (erasable

Number	Type	+5 V	GND	+12 V	−12 V
IC1	6116	24	12		
IC2	6116	24	12		
IC3	74LS373	20	10		
IC4	74LS373	20	10		
IC5	74LS138	16	8		
IC6	74LS240	20	10		
IC7	74LS240	20	10		
IC8	74LS240	20	10		
IC9	74LS240	20	10		
IC10	74LS240	20	10		
IC11	NS455	48	24		
IC12	74LS373	20	10		
IC13	74LS373	20	10		
IC14	2716	24	12		
IC15	74LS374	20	10		
IC16	74LS154	24	12		
IC17	74LS123	16	8		
IC18	74LS244	20	10		
IC19	MC1488		7	14	1
IC20	MC1489	14	7		
IC21	74LS86	14	7		

Table 5: *Power connections for integrated circuits in figure 4 (page 46). Another EPROM could be substituted for the 2716 in some applications.*

programmable ROM). The Term-Mite ST could potentially handle up to 8K bytes of external program memory (a type-2764 EPROM), which would allow the control program to be enhanced—perhaps to include more features or to emulate the display protocols of popular commercially sold terminals.

The display format is 24 lines of 80 characters, with a 25th reverse-video status line. The particular TMP version I have chosen uses a 12-MHz crystal and displays characters in a 5- by 7-dot matrix in a 7- by 10-dot character area. The masked program automatically configures the correct horizontal and vertical frequencies.

In figure 4, IC1 through IC5 constitute the video-display memory section. Two type-6116 static RAM chips (IC1, IC2) form a 2K-word display memory of 16-bit words. The low-byte chip (IC2) contains the ASCII character codes, while the high-byte chip (IC1) holds the screen attributes. The attributes supported are listed in table 4, with their relation to bits in IC1 shown.

IC3 and IC4 are the type-74LS373 address latches for the display memory. When any access to external display memory occurs, the address of the location is set on lines SB0 through SB15 and loaded into these two latches on the occurrence of the address-latch-enable strobe (RAM ALE) signal. Address bits A12 through A15 are decoded through a 74LS138 (IC5) to provide eight enable lines for the memory-mapped I/O as described previously. Depending upon whether the instruction is a memory-read or memory-write operation, either the active-low $\overline{\text{RAM RD}}$ or $\overline{\text{RAM WR}}$ line will be logic 0 (active).

Not all the decoded address-strobe signals are used in the Term-Mite ST, and only eight of the nine possible are implemented. To cut down on the number of chips, I decided to limit the display memory to a single 4K-byte page and not include a printer-output port. The software as supplied still supports four pages and the printer, so you may expand on the basic design if you feel resourceful and feel like wiring a few more chips.

As with all construction projects I had to observe practical limits when I froze the design.

The remaining memory-mapped I/O devices are three configuration switches (buffered through IC6, 7, and 8—three 74LS240 chips) and 12 bits of scanned keyboard data (buffered through IC9 and 10). Each device is addressed and its data gated onto the bus during the $\overline{\text{RAM RD}}$ pulse. Next month I'll describe these switches and the scanning logic in greater detail.

On the right-hand side of the TMP (IC11) is the program-memory (EPROM) and user-I/O circuitry. In a process similar to that described for the display memory, an address is loaded into the latches IC12 and IC13 during the active state of the ROM ALE; the EPROM data is read during the $\overline{\text{PSEN}}$ pulse. Type-2716, -2732, or -2764 EPROMs may be used (with proper jumper selection).

A parallel keyboard, instead of a scanned keyboard, may be connected to the Term-Mite ST through the type-74LS244 buffer IC18. Of the 8-bit input port, 7 bits are used to transfer ASCII data, while the eighth bit is borrowed for RS-232C handshaking. The keyboard strobe (active-low) connects directly to the RE10 TMP line and generates an interrupt when active.

Serial communication is handled directly by the TMP through an on-board UART. The data rate and protocol are set via configuration switches, and full handshaking is supported. The MC1488 buffer and MC1489 driver are connected directly to the TMP.

The TMP also has a direct output line for a bell signal trigger. The pulse is generated whenever a Control-G code is output or whenever the cursor reaches column 72 on the display screen. The trigger pulse is only a few microseconds long, so that a monostable multivibrator, or one-shot (IC17), is needed to stretch the pulse and drive a self-contained piezoelectric transducer.

Video output from the TMP is in the form of separate horizontal sync, vertical sync, and luminance signals. IC21, in combination with some discrete components, merges these to generate a composite-video signal. Because of the wide bandwidth re-

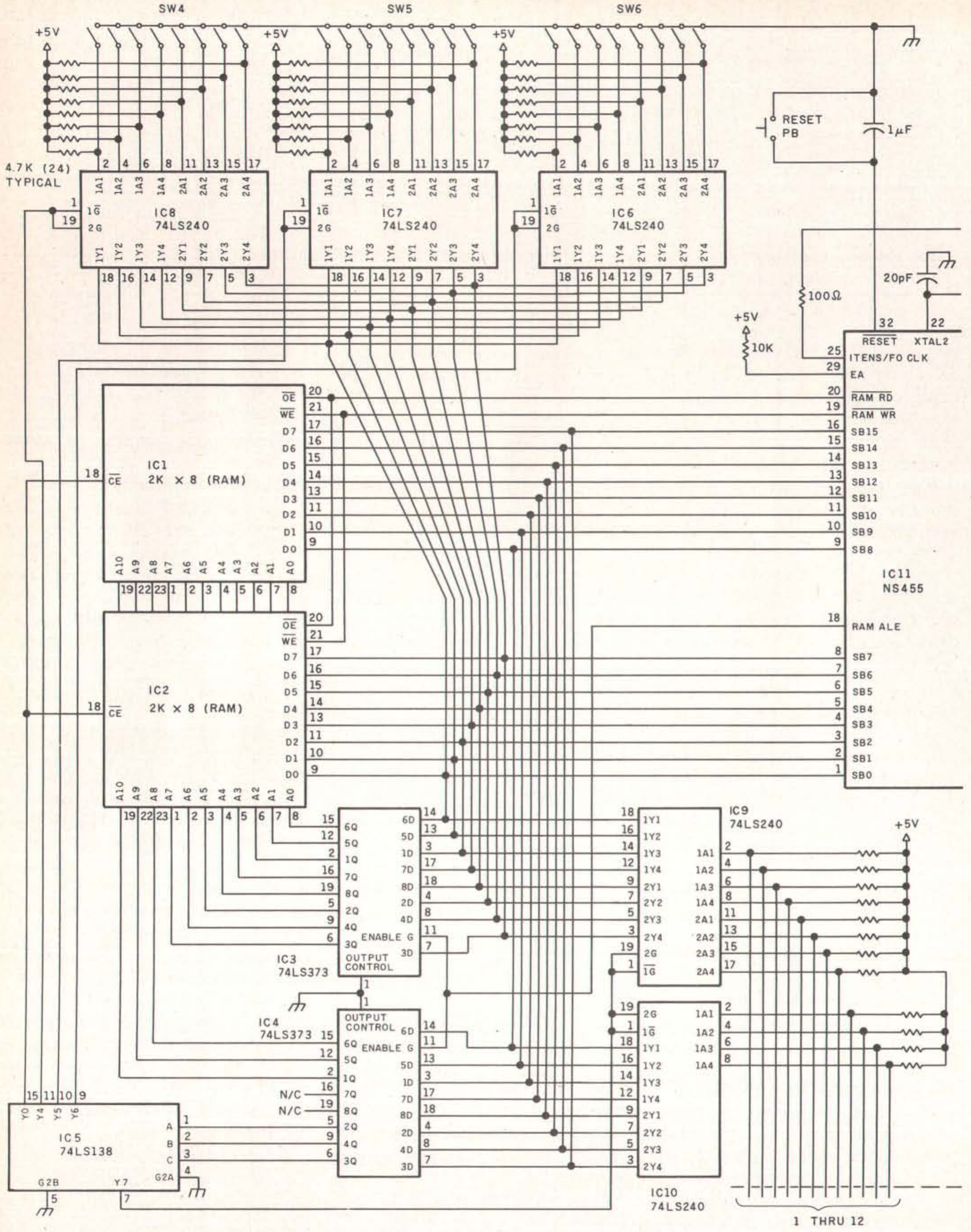
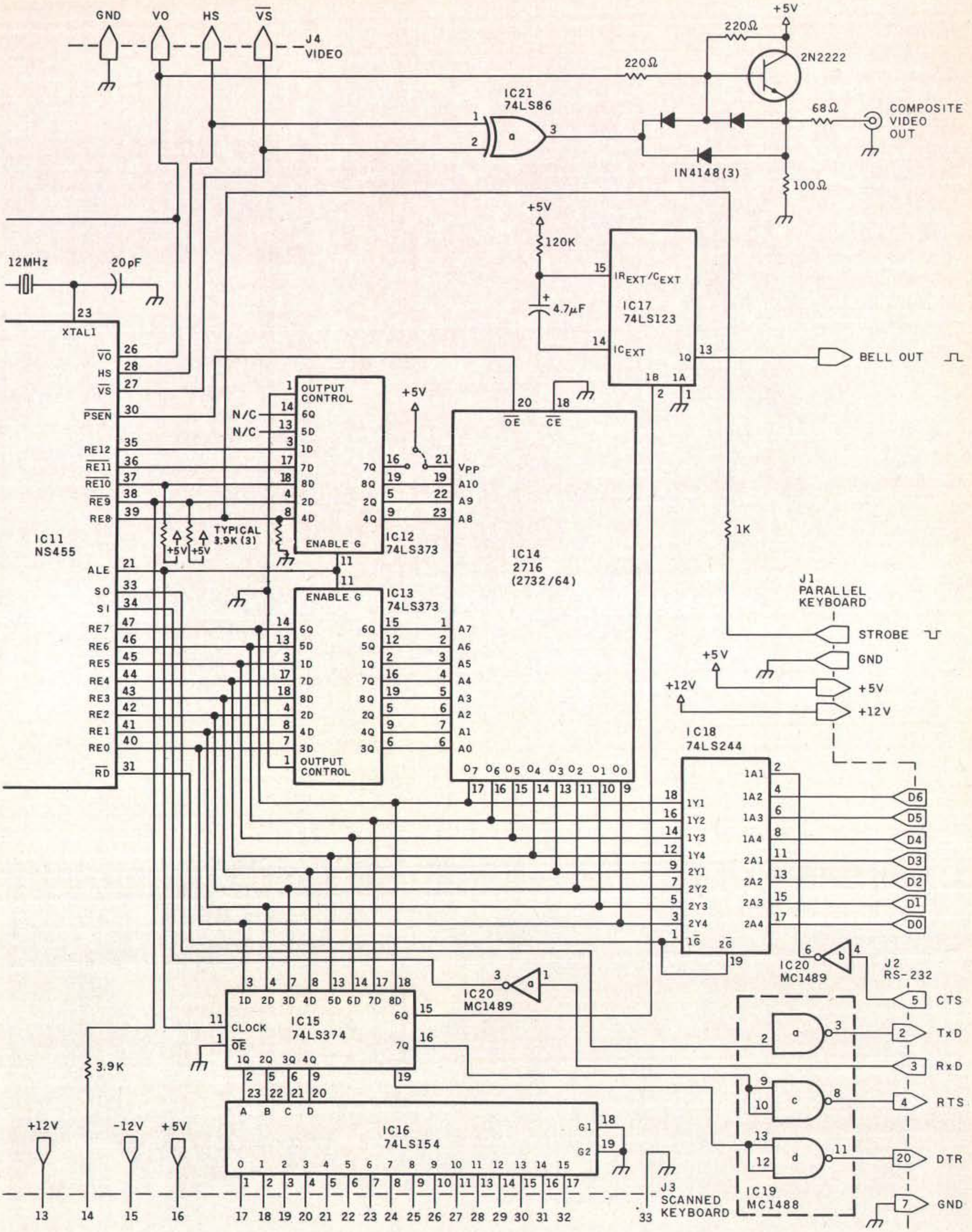


Figure 4: *Schematic diagram of the Term-Mite ST. The NS455A's usual stock terminal-control program is here contained in a 2K-byte type-2716 EPROM (erasable programmable ROM).*


GND
VO
HS
VS
J4
VIDEO
+5V
220Ω
2N2222
220Ω
IC21
74LS86
a
68Ω
COMPOSITE
VIDEO
OUT
1N4148(3)
100Ω
+5V
120K
IC17
74LS123
IREXT/CEXT
ICEXT
4.7µF
1Q
1B
1A
BELL OUT
12MHz
20pF
XTAL1
IC11
NS455
VO
HS
VS
PSEN
RE12
RE11
RE10
RE9
RE8
ALE
SO
SI
RE7
RE6
RE5
RE4
RE3
RE2
RE1
RE0
RD
N/C
N/C
OUTPUT
CONTROL
ENABLE G
IC12
74LS373
TYPICAL
3.9K (3)
IC13
74LS373
IC14
2716
(2732/64)
OE
CE
VPP
A10
A9
A8
A7
A6
A5
A4
A3
A2
A1
A0
O7 O6 O5 O4 O3 O2 O1 O0
1K
J1
PARALLEL
KEYBOARD
STROBE
GND
+5V
+12V
IC18
74LS244
1A1
1A2
1A3
1A4
2A1
2A2
2A3
2A4
1Y1
1Y2
1Y3
1Y4
2Y1
2Y2
2Y3
2Y4
1G
2G
D6
D5
D4
D3
D2
D1
D0
IC20
MC1489
b
J2
RS-232
CTS
TxD
RxD
RTS
DTR
GND
IC20
MC1489
a
IC15
74LS374
CLOCK
OE
1D 2D 3D 4D 5D 6D 7D 8D
6Q
7Q
1Q 2Q 3Q 4Q
IC19
MC1488
a
c
d
3.9K
+12V
-12V
+5V
IC16
74LS154
A B C D
G1
G2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
J3
SCANNED
KEYBOARD
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

quired for the 80-column display, you would probably have limited success using an RF (radio-frequency) modulator and TV set. I recommend that you use a high-quality CRT monitor for best results.

Although the current 2K-byte control-software release does not support it, the hardware provides a light-pen input in the form of an interrupt to the TMP. With proper programming, you could get the TMP to remember where the electron beam was scanning when the interrupt happened and subsequently return a value giving the location to the program. And with the proper software running in the host computer, all sorts of menu-driven tasks could be handled in this way.

Next Month:

In part 2 we'll examine the TMP software more closely and explain exactly what all the Escape and control sequences do.

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, product development, and marketing. In addition to writing for BYTE, he has published several books. He can be contacted at POB 582, Glastonbury, CT 06033.

Special thanks to Bob Harbrecht of National Semiconductor Corporation for his help with this project.

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.*

Ciarcia's Circuit Cellar, Volume I *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains articles from July 1980 through December 1981.* Ciarcia's Circuit Cellar, Volume IV, *soon to appear, will contain articles from January 1982 through June 1983.*

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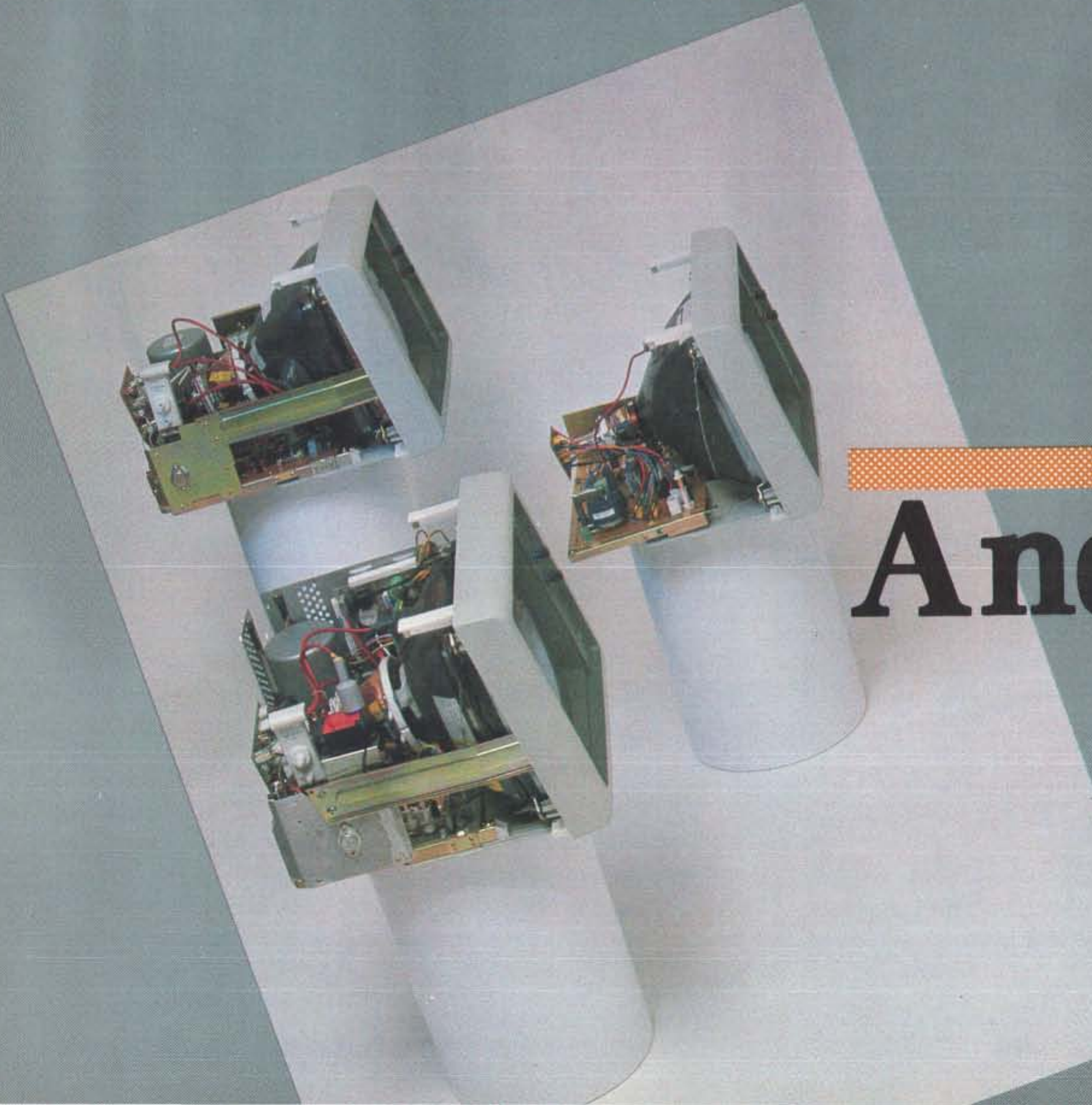

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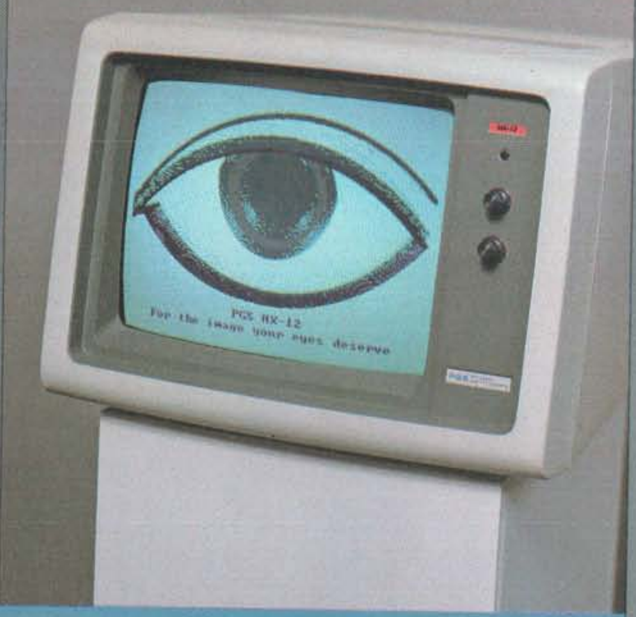

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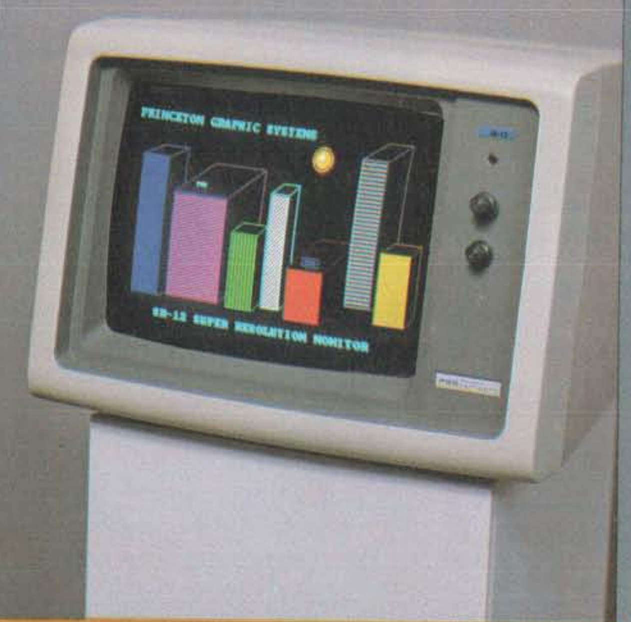

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Beyond the Word Processor

The time has come for text-editing software to surpass the paper operations it mimics

by Phil Lemmons

To date, most personal computer software has enabled us to do familiar tasks more efficiently. With a word processor, for example, we can prepare documents, alter them, and generate clean copies more easily than is possible using a typewriter, paper, liquid correction fluid, and an eraser. While the Block Move commands in word processors make rearranging text simpler and encourage writers to revise, nothing about word processors makes it easier to create a document when the ideas are still in a formative stage or to analyze a document that is already complete.

Spreadsheets are the great exception. They let us analyze related numerical parameters in a way never before available to individuals. Some may dispute this view, saying that spreadsheets just let us look at more alternatives than we could using paper and calculator. The contribution of the spreadsheet program, in this view, is merely an improvement in efficiency over customary methods.

But spreadsheet software contributes much more than increased efficiency. As you watch the effects of changing one figure ripple through a whole model, you are able to think in larger terms than a calculator and paper allow. Furthermore, the visual rippling itself sometimes is tantamount to a graphical simulation of the problem under study. You gain a better understanding of relationships in the model and a feeling for the probable consequences of different kinds of changes. When a change causes startling results, you realize that either the model doesn't reflect reality or the reality is different in some important way from what you thought. The spreadsheet software provides a ready means for analyzing the startling result.

The time has come for text-editing software to surpass the power of the paper operations it mimics. To date, word processors have taken conceptually complete documents and printed them out neatly. The most interesting and difficult part of preparing many text documents, however, comes much earlier—when concepts are inchoate and their interrelationships are dimly understood. Text editors for programmers have provided "macros" that permit automatic execution of a series of operations, but the operations chained are usually a series of search-and-replace operations designed to achieve a result that conforms to the rigid syntax of a programming language.

Can software help us grope through the earlier stages of text composition? Can it help us analyze finished documents?

Let's take a case in point. In the early stages of composition, the writer is thinking things through. Although the writer is putting words on paper, he or she is grappling with concepts that encompass more than single words or phrases or even paragraphs. Take a work of fiction, for example. As the author writes, he or she thinks about large ideas such as characters, atmosphere, and plot. The author may be reflecting on the character George and whether he develops convincingly, or about how to give a scene a spooky atmosphere before George enters, or about how to build suspense before the climax. The writer thinks in terms of George's character as it extends and evolves throughout the novel. He or she thinks of the scene that is meant to be spooky as one that builds on preceding scenes and prepares for subsequent scenes and wonders how to build suspense in terms of creating and resolving tensions between characters.

Regardless of what the writer is thinking, however, the word processor can directly manipulate words and phrases only. What the word processor can directly manipulate is much smaller than what the writer's mind can directly manipulate.

How could text-editing software help the writer grapple more directly with concepts larger than words and phrases? I offer a few suggestions, again with reference to fiction. A utility called Character could extract some specifiable number of sentences before and after each occurrence of a character's name (let's call these "character blocks") and assemble all the extractions (in a "character summary") for convenient viewing by the writer. The CHARACTER command might have switches that select specifiable kinds of information from the character blocks rather than the entire blocks. For example, verbs, adverbs, and adjectives that express feeling might all be pulled out of the manuscript to give the writer a check on the character's emotional evolution. Terms likely to be used in physical descriptions of the character might similarly be extracted. A pop-up menu headed "Character" might have these subheadings:

- Feelings
- Physical description
- Actions
- Associations
  - People
  - Places
- Spoken words

Another command, PLACES, could extract all the passages in which the character is mentioned in connection with any country, city, town, building, room, and so on. A command called ATMOSPHERE could extract all passages containing terms of color, feeling, sound, etc., in connection with a specifiable place.

The next step in making software more useful to a writer would be to allow use of Boolean operators with these commands. It would be useful, for example, if a writer could ask for all passages containing references to both the character Tom and the room cellar.

This special text editor would gain tremendous power if it enabled the writer to insert markers that correspond to milestones, such as chapter breaks, scene breaks, climax, denouement, and so on. The other commands could then present their data in relation to the milestones. It would be handy, for example, to see how a character's feelings or actions after the climax compared with those before. Using Boolean operators along with milestones, the writer could quickly select information that shows how a character feels about a certain place both before and after the climax of the story. Since characters' emotions are often expressed in relation to the objects around them, the combination of milestones and Boolean operators would be a powerful characterization tool.

An equally useful extension would let the writer specify a new command, a list of menu items to appear when the command is invoked, and a list of words and phrases to search whenever the writer used the command and specified a menu item.

It is worth noting that none of these suggestions for developing an editing program for writers of fiction would do anything to replace or diminish the writers' creativity. The commands would merely give the writer quick access to information that related to developing concepts in the story. The writer could check how the text on disk compared to the writer's current ideas about a character, place, and so on. As the writer's ideas changed, the editing commands would help extract the relevant passages to speed the reshaping of the text to reflect the writer's changed ideas.

Special Functions for Special Needs

Just as fiction writers have special needs, so do writers of other kinds of documents. In writing a proposal for funding, for example, it would be useful to have the document summarized instantly in terms of its references to objectives set in the RFP (Request for Proposal). Tracing each objective against a time line would be another helpful feature. Inveterate proposal writers could suggest other features.

In narrative writing, it would be useful to be able to extract the sequence of tenses in a piece; in history especially, to extract the sequence of dates and times.

Business writers could suggest special editing features for business plans and annual reports. Commands that extracted all numerical information and plotted it against a time line would be useful during writing. Another helpful command would extract paragraphs containing references to specified divisions, departments, positions, or persons. Boolean operators would be as helpful here as in fiction.

Other missing facilities would help writers in all fields. One problem in any extended piece of writing is to make strong transitions from one section or chapter to the next. A command that extracted the last two paragraphs of each section and the first two paragraphs of the following section would let the writer have a quick look at all the transitions in the document.

Good Signs

Two programs that go beyond word processing are now on the market: Thinktank, from Living Videotext in Palo Alto, California, and Zyindex, from Zylab Corporation in Chicago, Illinois. Both these programs recognize that a collection of words can be much more than a finished document. They give the user new ways of getting hold of information contained in text files.

In the case of Thinktank, available for the Apple IIe for $150 and the IBM PC for $195, you obtain information through a tree structure. A document is a large outline. There are headings and subheadings ad infinitum, but you see only as much of the outline as you wish. The EXPAND and COLLAPSE commands control what you see. Thinktank displays a "+" in front of every heading that has further information under it. You know you have reached the end of a branch when a "−" sign precedes a heading. If you use the EXPAND command on an item that is preceded by a "+", the next level of branches will be displayed. You can expand your way through level after level. When you want to concentrate on the more general levels of the outline, you use the COLLAPSE command to hide the levels that give details. By expanding and collapsing, you can delve into the tree of data or concentrate on only the broad headings. You can also move items about in the structure, promoting them to higher levels or moving them to other parts of the outline. You can insert new items and merge old ones as well.

Thinktank, then, is most useful when a document is in the formative

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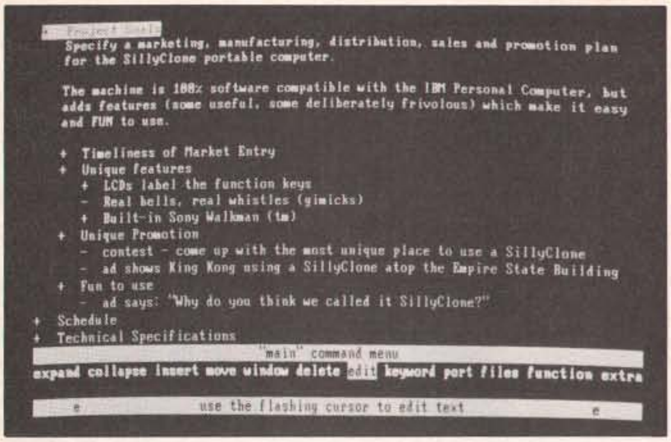


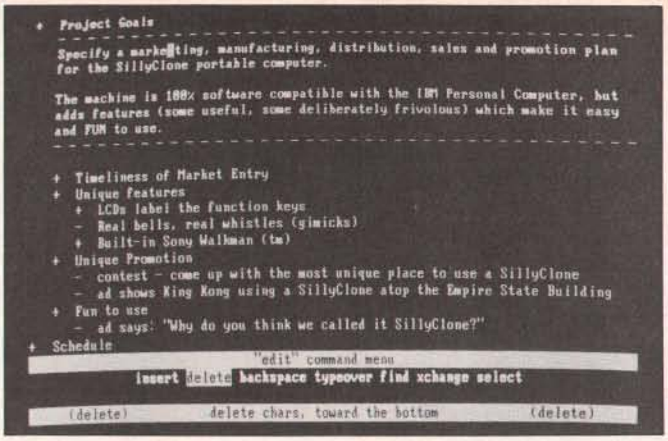
```
+  Project Goals
    Specify a marketing, manufacturing, distribution, sales and promotion plan
    for the SillyClone portable computer.

    The machine is 100% software compatible with the IBM Personal Computer, but
    adds features (some useful, some deliberately frivolous) which make it easy
    and FUN to use.

    +  Timeliness of Market Entry
    +  Unique features
       +  LCDs label the function keys
       -  Real bells, real whistles (gimicks)
       +  Built-in Sony Walkman (tm)
    +  Unique Promotion
       -  contest - come up with the most unique place to use a SillyClone
       -  ad shows King Kong using a SillyClone atop the Empire State Building
    +  Fun to use
       -  ad says: "Why do you think we called it SillyClone?"
+  Schedule
+  Technical Specifications
                          "main" command menu
expand collapse insert move window delete edit keyword port files function extra

     e                use the flashing cursor to edit text                  e
```

Photo 1: *Thinktank in use, with the main command menu shown. The EXTRA command at right leads to a second list of commands. Each item preceded by a "+" can be expanded to show subheadings or paragraphs, while each item preceded by a "−" represents the end of a branch.*



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+  Project Goals
   - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Specify a marketing, manufacturing, distribution, sales and promotion plan
   for the SillyClone portable computer.

   The machine is 100% software compatible with the IBM Personal Computer, but
   adds features (some useful, some deliberately frivolous) which make it easy
   and FUN to use.
   - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   +  Timeliness of Market Entry
   +  Unique features
      +  LCDs label the function keys
      -  Real bells, real whistles (gimicks)
      +  Built-in Sony Walkman (tm)
   +  Unique Promotion
      -  contest - come up with the most unique place to use a SillyClone
      -  ad shows King Kong using a SillyClone atop the Empire State Building
   +  Fun to use
      -  ad says: "Why do you think we called it SillyClone?"
+  Schedule
                          "edit" command menu
           insert delete backspace typeover find xchange select

     (delete)          delete chars. toward the bottom          (delete)
```

Photo 2: *The edit menu of Thinktank. Although not a word processor in the usual sense, Thinktank does include a good text editor.*

stages. As your ideas change and various aspects of them become more and less important, you can alter the document to reflect the changes. However much rearranging you do, Thinktank leaves you with a neat outline that looks as if you understood the subject when you started out.

In a way, Thinktank is analogous to a spreadsheet. A spreadsheet lets you rearrange numbers and relationships until you find a coherent arrangement that shows how to attain your goals. Thinktank manipulates text in a way that lets you rearrange its internal logical relationships until the structure supports a main idea. A spreadsheet is a number manipulator. Thinktank is a text manipulator.

Living Videotext calls Thinktank an "idea processor" to distinguish it from a word processor. While the term is a bit optimistic, it will have to do until a better one comes along. Thinktank's specific contribution is to apply tree structures to text. Its more general contribution is to treat a body of text as a database whose parts happen to be text.

Photo 1 shows a sample screen from Thinktank. As the main command menu reveals, Thinktank lets you search for items based on keywords. This search differs from one in a word processor in that it finds paragraphs or branches that contain a keyword—not just the keyword. In other words, you can confine your search for a keyword to a particular area. Selecting the EXTRA command at the right of the main menu brings a menu of extra commands, including PROMOTE, which promotes a subheading to a higher level. Photo 2 shows the edit menu, displayed after you select the EDIT command from the main menu.

Zyindex, too, treats text as a database. This program lets you search a body of text for occurrences of any word, or of any two or more words within a specifiable number of words of each other. What makes Zyindex so much more valuable than the Search function of a word processor is the availability of Boolean operators. You can look for any occurrence of either "Johnson" or "Holmes" within 100 words of "embezzlement." Or any occurrence of both "Johnson" and "Holmes" within 100 words of "embezzlement."

Zyindex works by making an index of all the informational words in what it calls a textbase. That is to say, the index excludes "noise" words, such as prepositions and conjunctions. You make a search request with Zyindex by combining content terms with connector words. The connector words are OR, AND, NOT, WITHIN, and ( ) [parentheses]. NOT represents the exclusive OR, and the parentheses are used to mark the scope of the other connectors. Zyindex will print out all the files that conform to a request or let you peek at the relevant passages within those files. Zyindex runs on the IBM PC, requires 192K bytes of RAM and two double-sided drives, and costs $295.

Zyindex enables you to test for relationships among items in an index. You can extract relevant information quickly to test a theory, to support an argument, to confirm an association, or to speed analysis of a body of text that resides on disk.

Programs like Thinktank and Zyindex show that word processing is the least interesting part of processing text; the interesting parts are during the generation of ideas, which Thinktank aids, and during the analysis of a body of information accumulated in text files, which Zyindex aids. These programs hold great promise because they show that programmers are thinking of ways to let personal computer users do more with text than print clean copies and individually addressed form letters.

If anything is holding back development of software for text manipulation, it is the failure of those of us who create, edit, and analyze text to specify features that would be useful to us. In the age of the typewriter, there was no point in dreaming of such features. In the age of the personal computer, expressing our dreams may result in products that make such features a reality.■

Phil Lemmons is managing editor of BYTE. He can be reached at POB 372, Hancock, NH 03449.

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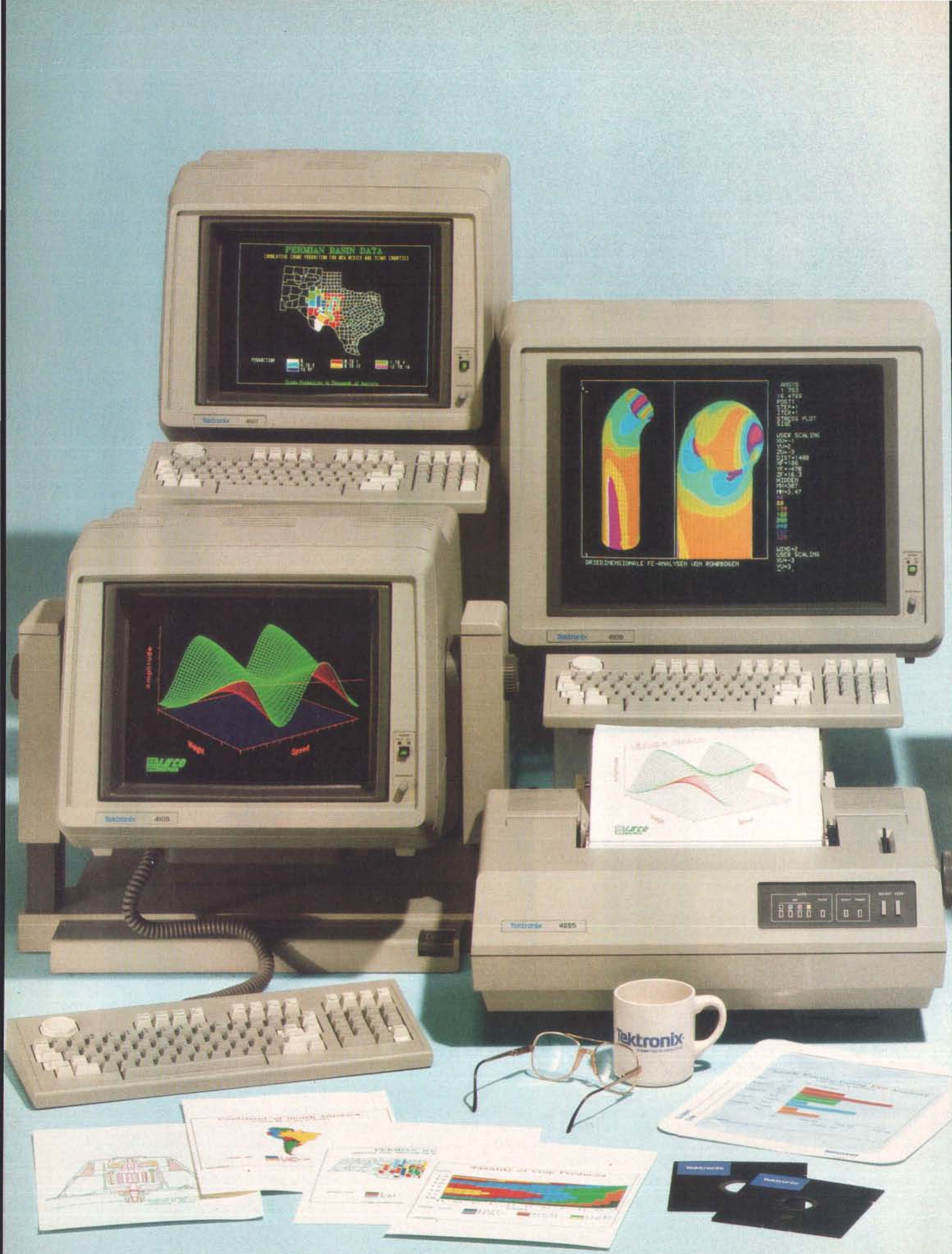

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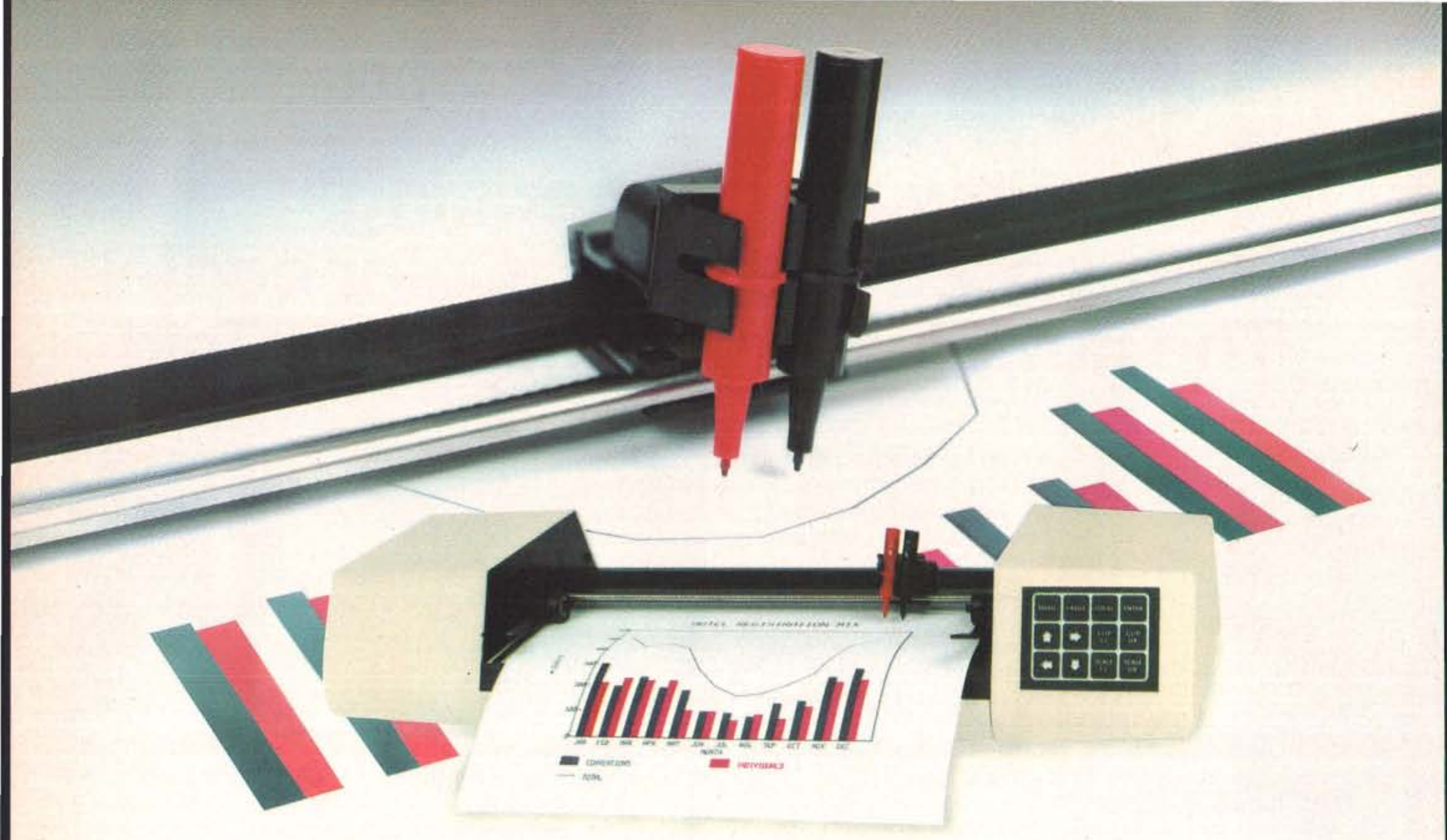

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User's Column

Too Many Leads, or What in *;?!#″*? Goes First?

In a heavy news month, our user covers several important items

by Jerry Pournelle

This has been the month of the changing lead. It began with upgrading the Eagle 1600. Then Tyler Sperry brought over the Kaypro 10, a portable machine with a hard disk. We'd no sooner got that running than the Osborne Computer Corporation filed for Chapter 11, and that needed commenting on. Then I got upset by the mess Congress is making out of attempts to promote computer literacy, but before I could write anything about it, Epson sent us yet another version of Valdocs for the QX-10.

Just after that, I got a copy of the legal reasoning in the *Apple* v. *Franklin* suit, which holds that "a computer program, whether in object code or in source code, is a 'literary work' and is protected from unauthorized copying." There are some powerful implications in that. For one thing, if program publishers rely on copyright, how can they expect to enforce those silly licensing agreements they foist off on us?

If all that weren't enough, I went to CP/M East in Boston, where Digital Research's Gary Kildall displayed DR Logo and Bill Godbout held a big clambake to celebrate Compupro's tenth anniversary. Godbout also unveiled the Compupro 10, formerly yclept Shirley, and there's a story to go with that. Rod Coleman was there, too, with the new Sage IV, which is a good candidate for the best available computer based on the 68000 chip. Finally, after CP/M East I paid my very first visit to BYTE headquarters in Peterborough, New Hampshire.

Any one of these events would be important enough for the lead item in the column, but none of them is, because on the way to Peterborough I stopped at Steve Ciarcia's Circuit Cellar.

Quicksilver

Steve has designed an absolutely dynamite upgrade to the IBM PC. He asked me not to do the full story this issue, because he's still playing around with the way he wants to package it. That's fine, but if you're at all short of money, don't buy anything for your PC until you've seen Ciarcia's Quicksilver. I can darned near guarantee it will be the first thing you'll want.

Quicksilver is a one-card computer that uses the IBM PC as a power supply, disk drive, and smart terminal. It has its own CPU (central processing unit, or brain) aboard. Using Quicksilver is simple: you preload a PC BASIC compiler that appears as if it's in ROM and write a program in BASIC, doing all your debugging and logic testing in the usual way. Then you run it under Quicksilver, which compiles the program in seconds as you "load" it. Then it executes the compiled program. The results are astounding. I might not have believed it if I hadn't seen it myself: programs run *100 times as fast*.

If that weren't enough, Quicksilver also lets you run CP/M-80 programs and has a C compiler. There's also a structured assembler and a text editor integrated with the BASIC compiler. I didn't myself see those features work, but I've no reason to doubt that they do. Ciarcia has a habit of getting things right.

Incidentally, for the congenital doubters among our readership: there really is a Circuit Cellar, and it really is in Steve's basement.

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However, if you picture a basement as a damp, messy place, get rid of *that* image. Ciarcia's Circuit Cellar is none of that. Most of it is carpeted, with paneled walls and designer furniture, more rec room than cellar. In the middle of all that is a work area with wide Formica-topped counters and lots of test equipment.

It's also *neat*. In fact, although they're tearing Steve's house apart to put in a new kitchen, the whole place is neat, which suggests that Steve and his wife, Joyce, have some fundamental secret that escapes the rest of us. Every time I see a place like his, I get fantastic plans. If I just add storage cabinets here and bookcases there, I too could have some bare counter tops, and chairs not piled with paper and boxes, and somewhere to put things as they come in.

Then I come home to Chaos Manor. Ah, well.

Survival

I'm writing this in early October. Just at the moment, in obvious reaction to the Osborne disaster, both computer and mainstream magazines are full of articles and editorials about "the great shakeout" in the micro industry. A number of companies are said to be in trouble, and "experts" are predicting that we've reached a new age in micros, one in which only the giants like IBM can survive.

I don't believe that.

I suppose the micro industry will be dominated by the giants—but there's plenty of room for the others. In U.S. business as a whole, about 10 percent of all sales are made by companies with a gross income of less than half a million dollars. There are some 5 million of them. Another 35 percent of all sales are made by the 520,625 companies with gross incomes of $500,000 to $25 million. At the other end of the spectrum, a bit less than half of all sales are made by the 2355 companies with gross incomes of $100 million or more.

That's all U.S. business, from steel rails to books to coffee spoons. The computer industry is skewed a bit more toward smaller companies. I

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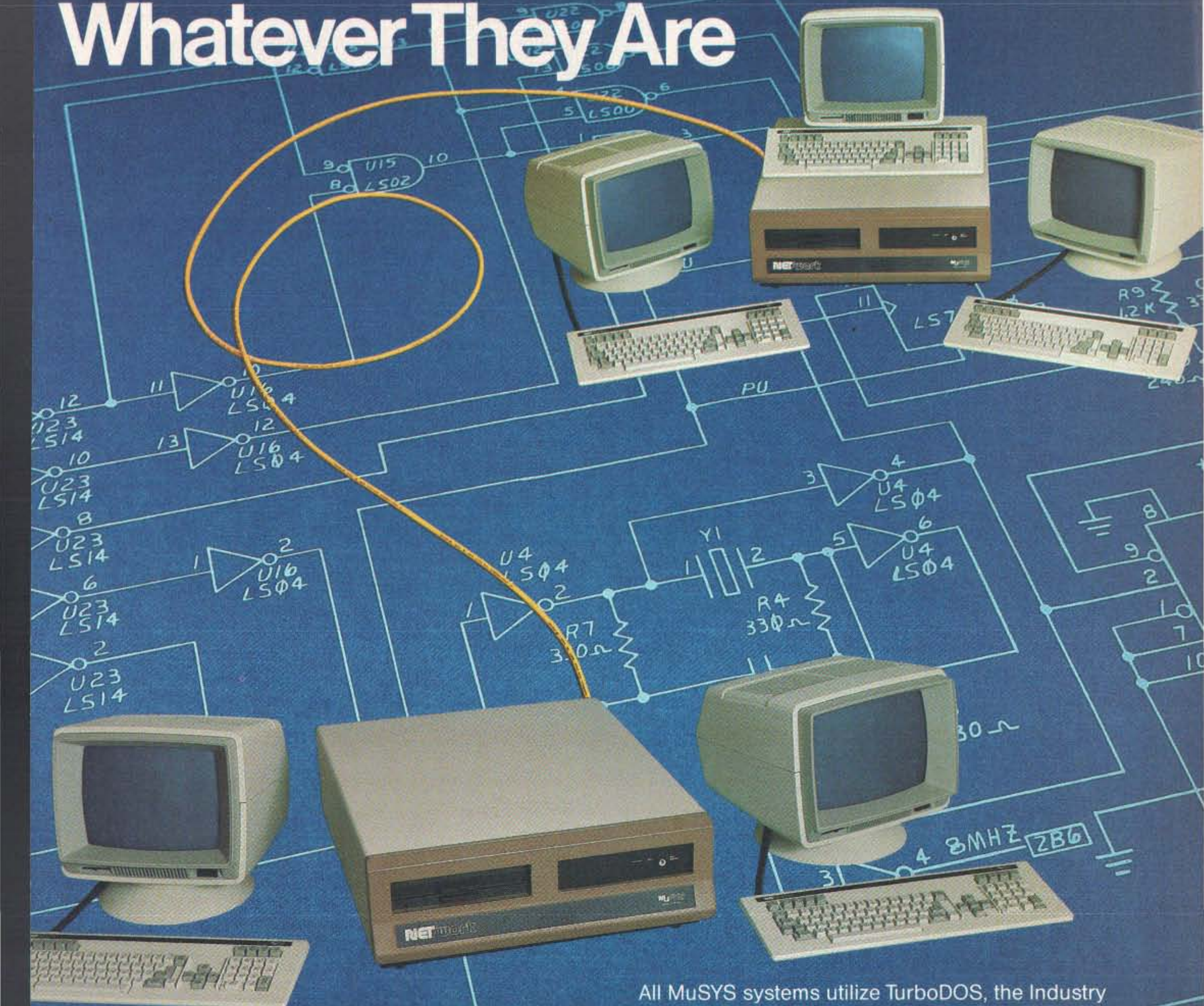

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think it will stay that way, because the micro world changes like dreams, and smaller, leaner companies, with fewer links in the decision chain, can respond faster to changes in technology.

The giants look to big sales, hundreds of thousands of copies of nearly identical units. While they're setting up to do that, the small, adaptable, fast-moving outfits get their innings.

Example: there's a persistent rumor that IBM has developed a small, portable computer based on the iAPX186 CPU chip. The problem is that Intel isn't producing the chips fast enough. It has had to put its customers on allocation.

IBM can't work that way. However, if you really want an iAPX186 computer, Slicer will be glad to sell you one. It comes without frills. There's no case and no power supply, but it works. Jim Hudson and I are doing an article on the Slicer, which is a good buy for technically sophisticated users. My point, though, is that Slicer can make profits on its machine, even though the company will never have any large share of the microcomputer market.

Another example: I first met Rod Coleman at a West Coast Computer Faire. Forty days before the Faire, his Sage Computer Technology company was destroyed by a disastrous fire. Rod was standing there with his three working machines. None had a hard disk; he'd show you melted fragments and refer to them as "our well-burned-in disk drive." In less than a year, Sage was doing a million dollars' worth of business annually; I recently got an announcement that the company had had a million-dollar month, and it hasn't stopped growing. The Sage IV may well be the best 68000-chip computer on the market.

Yet another example: even as Osborne was getting into trouble, Kaypro was growing by leaps and bounds. The reasons for that are complex, and indeed Kaypro couldn't possibly be doing as well as it is if Osborne hadn't led the way; but it does show that small, well-made, and well-thought-out systems can thrive. The Kaypro 10 is the first portable machine to use a hard disk. Other innovations are coming.

A final example. Bill Godbout just threw a big party to celebrate the tenth anniversary of Compupro. Here's a company with a reputation for armor-plated high-technology hardware. It very nearly dominates the development systems market. Now it's trying to expand its market share by selling easy-to-use business systems.

Last time I looked, Compupro had maybe 2 percent of the micro market. That doesn't sound like much—but if you look at Compupro's actual dollar income, it has been doing business at a steadily rising rate. Most accountants would sell their livers for that kind of profitability.

At the height of the Osborne boom, the company was shipping around 8000 computers a month, which generated sales on the order

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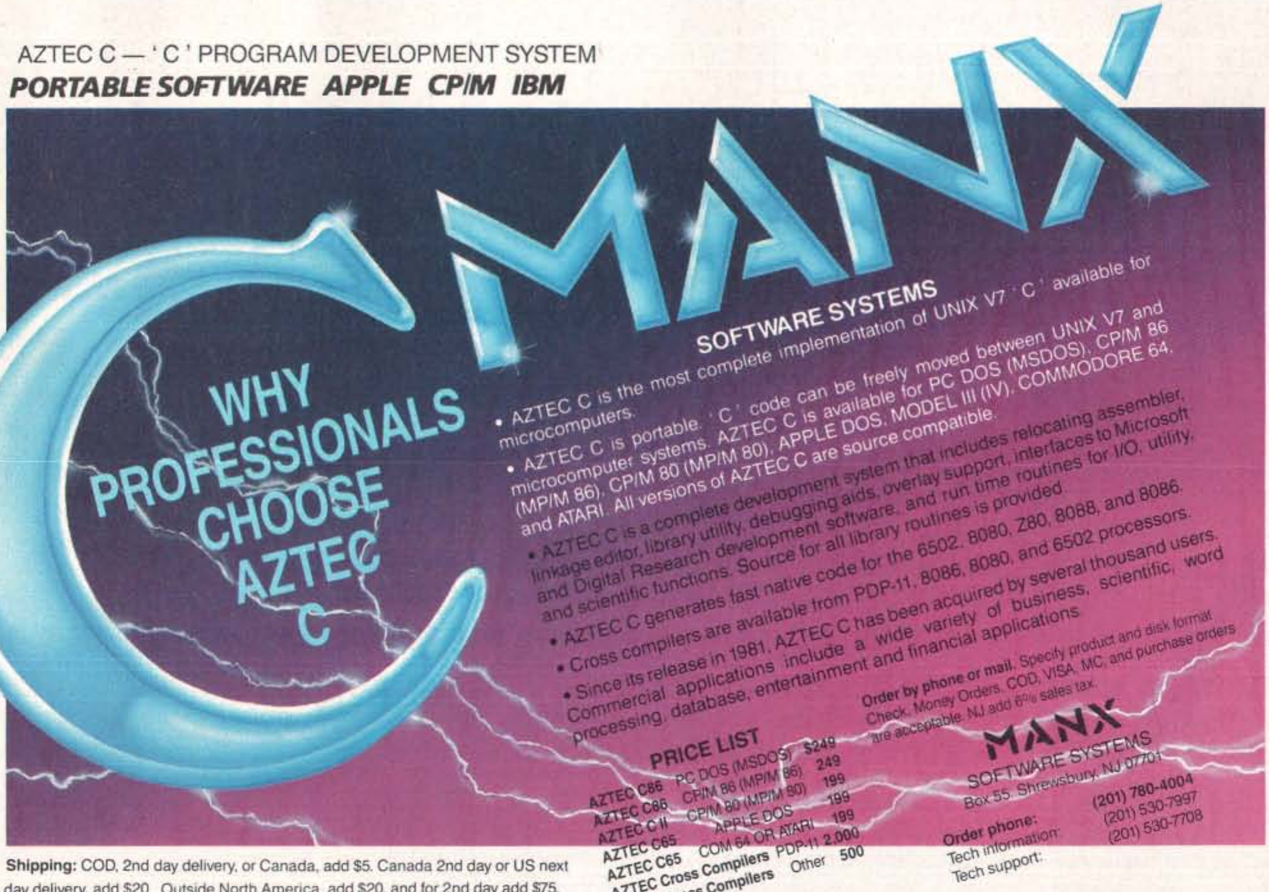
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of $100 million a year. That may not be big by IBM standards, but it's not peanuts, and it made Osborne one of the Big Ones in the micro field.

There are 5.5 million U.S. companies, and just about every one of them will spend $2000 a year on microcomputers. There are at least a million people who spend a thousand dollars a year on personal computer products, and I'd be greatly surprised if that number didn't hit 10 million in the next few years. One-half of one percent of that is $105 million—Osborne's peak income.

Look at it another way. Assume sales are distributed by company size roughly the way they are in U.S. business as a whole.

Of $20 billion total sales, 10 giants will get half. The other half will support a thousand companies with average sales of 10 million dollars, which in practice is more likely to be 900 smaller outfits and 50 large ones. Even so, there's plenty of room.

This isn't to say that things won't get tricky. They always do when you're up against large resources. The big boys can survive mistakes that bankrupt small companies. They can afford to lose money setting up store outlets and service centers. They can also afford to advertise.

The smaller outfits also have some advantages. They don't have to tool up for big production runs, and their decision structures are leaner, so they can track new technology better. They may not have in-house service organizations, but as the industry matures there'll be more and more trained technicians. Some will stay independent, others will work for service companies like Xerox, which is rapidly becoming something like a cross between AAMCO and Tuneup Masters, only for micros. Parts outfits will spring up. Somebody's going to get rich out of stocking spare parts, repair kits, and instruction sheets.

It may happen that someday all the really exciting developments in the computer field will come from the research labs set up by the giants; but that hasn't happened yet, and I don't really think it will. In fact, I see small computers as the great equalizers. I think they're going to change the structure of business in this country, not just for the micro business, but for everyone, making it much easier for small outfits to compete with the giants; but that's a topic for another column.

Upgrading the Eagle 1600

One of the things we're hard at work on is Inferno, an Adventure-style game based on the novel that Larry Niven and I published some years ago. The original plan was that Larry and I would write the script for the game, and my son Alex would do the code. Alas, Alex finds himself spread almost as thin as I am. Fortunately, though, Marty Massoglia, who's both an experienced programmer and as mad on games as we are, became available just as we despaired of getting the project accomplished.

There remained the problem of what language to write it in. Since the original contract calls for the game to run on the IBM PC, we needed something available in PC-DOS; but we have delusions of sell-

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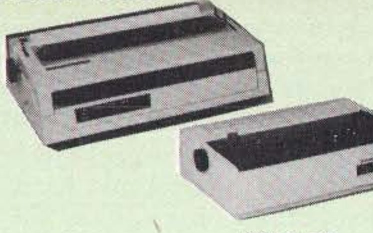

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ing this to the 8-bit CP/M world as well, so it needed to be portable. Of course, we'd originally intended to write it in Pascal, that being what Alex is most familiar with; and although Marty isn't, he didn't think it would give him any real trouble, since if you know a couple of computer languages it's not so hard to learn another.

There remained the question of what machine to use. The obvious answer, an IBM PC, was out: we ordered our PC direct from IBM last June. In late June IBM returned the check with a letter saying it had to be certified. By the time we sent a certified check it was early July. Since then IBM keeps telling us Real Soon Now, but as of October 9 there's no PC in sight [it arrived on November 1].

We do have the Eagle 1600, which runs PC-DOS and is a lot faster than the IBM PC. The only incompatibility would be screen-format commands and graphics, and we hadn't planned special graphics for Inferno anyway, so the Eagle looked like a good choice. Marty took the Eagle, along with Pascal/MT+86, which is the brand of Pascal that Alex favors for microcomputers. A few days passed while Marty familiarized himself with the machine, and with Pascal, and decided on the structure of the game.

Then came the problems. Pascal/MT+86 wouldn't compile. Instead, Marty got "Out of Memory" messages. He also had some suspicions about the text editor. Eaglewriter, which is Lexisoft's Spellbinder adapted for the Eagle, puts some strange formatting characters into the text. It also refuses to put in linefeed characters; like Write (which we do not yet have running on the Eagle), Eaglewriter uses a bare carriage return, no linefeed, as the "newline" marker.

"I don't think MT+ will compile it even if we have enough memory," Marty said.

"Well, that's easy to fix," said I. "Just write a little assembly-language filter that copies the files and puts in linefeeds. I have one here for the 8080. Surely it's not so hard to do for the 8088."

"Well, it is," said Marty, "because the assembler won't accept input without linefeeds."

At that point I had to leave town, and I turned the matter over to Alex. When I got back, he'd talked to the people at Eagle Computer and found out a lot of things.

First, that's not an 8088 in the Eagle. It's an 8086, which is exactly like an 8088, except it fetches data 16 bits at a time. Second, although ours came with only 128K bytes' worth of memory chips, the Eagle has sockets for 512K bytes of memory. You don't need to use up a bus slot to get it, either; those sockets are on the main board.

Alex called California Digital and ordered a slew of 64K-byte memory chips. Since they're 64K-byte by 1-bit memory, you need eight such chips for each 64K bytes of memory you're adding. However, both the Z-100 and the IBM PC require *nine* chips for each 64K bytes of added memory. This is because they do *parity checking*, a form of memory test, and thus need the extra memory to store the parity bits in. The Eagle doesn't do parity checking. Anyway, Alex ordered 20 memory chips, enough to put in 128K bytes of additional memory and bring the Eagle up to 256K bytes (plus a few spares).

[Last-minute notes: Eagle tells me it did a lot of work on parity checking and found that it decreases the overall reliability by 15 percent. The company decided it was better not to do it.]

Then the Eagle software people called. They'd tried Pascal/MT+86 in a system with 512K bytes of memory and *still* got "Out of Memory" errors. It seems those odd formatting characters in Eaglewriter, plus the lack of linefeeds, fool MT+86 into believing you're trying to compile one enormous statement.

However, there's a remedy. If, when you save your file under Eaglewriter, you add "/1" after the filename, the format characters are stripped out, and linefeeds are added after each carriage return. That's known as an undocumented feature.

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Alas, the Eagle is just *loaded* with undocumented features. It's a wonderful machine, and the documents are just great if all you want to do is run Eaglewriter and Eaglecalc, but ye gods they're incomplete if what you want is to understand the system.

Anyway, if you use the /1 option, the result is a normal ASCII file that compiles nicely. It would even have compiled with the original memory available. On the other hand, Pascal/MT+86 will use as much memory as the machine has available, and the more you have, the faster things go. Best to have a lot, thought Alex, and when our memory chips came from California Digital, he put 16 of them in.

He swears he did it right. I wasn't here, but I believe him. However, when he turned on the machine, it wouldn't talk to the keyboard. The IBM PC runs a memory check every time you turn it on, so if you have a lot of memory you can go get coffee while the system comes up; but alas, there's not even a voluntary memory-test program for the Eagle. However, when Alex replaced one of the memory chips—the first one, fortunately, since it's very hard to get at the memory while the machine is sufficiently assembled to be in an operative condition—things ran fine.

Since then we've had a couple of glitches, none fatal, and we very much wish we had some good diagnostic programs.

On the other hand, the time that the Eagle takes away with one hand, it gives back with the other: it's *fast*. You don't have to wait forever for programs to compile. It has a much nicer keyboard than the PC. It has eight IBM PC expansion slots in addition to the empty memory sockets. It's a great deal cheaper than a PC XT. It's designed for multiple users (under MP/M-86). I don't know whether it runs Concurrent CP/M-86 right out of the box, but it can't be hard to get it running. (As I've said before, I think Concurrent CP/M is *the* way to go for PC machines.)

[Late update: the Eagle does have memory tests. You hold down the "T" key on power-up or reset. This is yet another undocumented feature.]

As I write this, they're working hard at Eagle to update the documents and revise some of the software. I wish them well at it—but I sure wish they'd hurry. The Eagle is too good a machine to let the lack of documents and software developments spoil it.

Meanwhile, Marty and Dr. Cheryl Chapman are collecting their notes on what's wrong with the Eagle's documents. By the time you read this, we'll have written them up and sent them in to the Eagle people, who I'm pretty sure will make good use of them.

Write Now . . .

While Tony Pietsch takes in the Munich Oktoberfest, Noor Singh has been doing the work at Proteus Engineering and has now installed and optimized Write for some 40 different 8080, 8085, and Z80 systems. There's no 16-bit version yet, but it's unlikely you have an 8-bit machine, terminal, or printer that won't run

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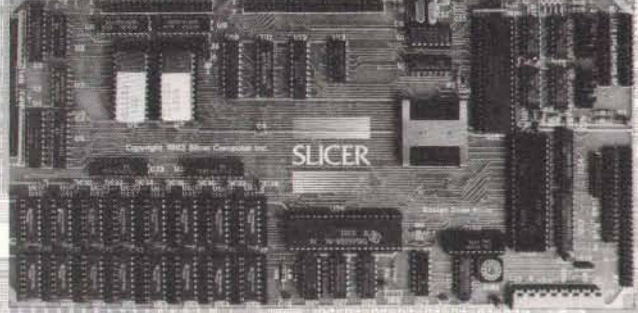

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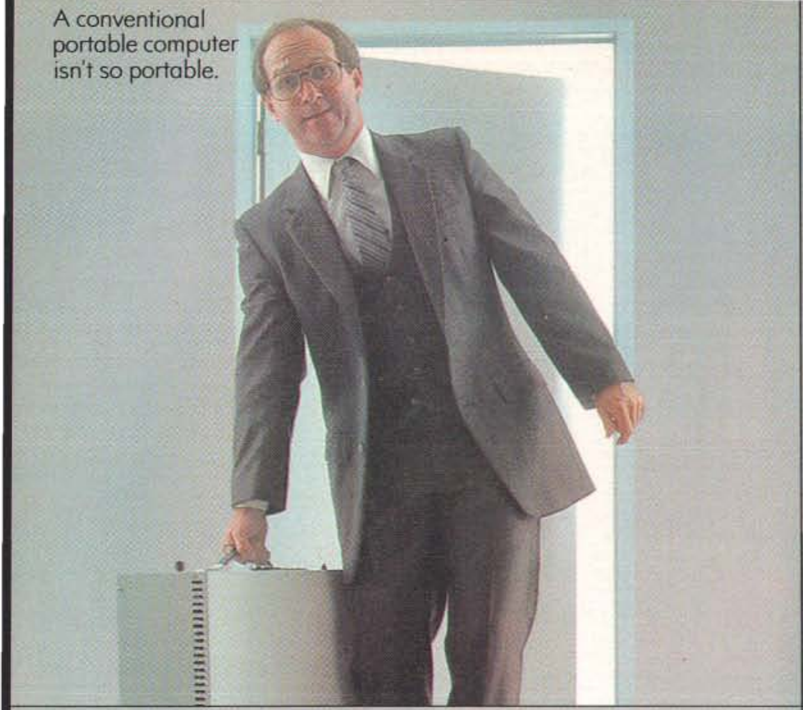
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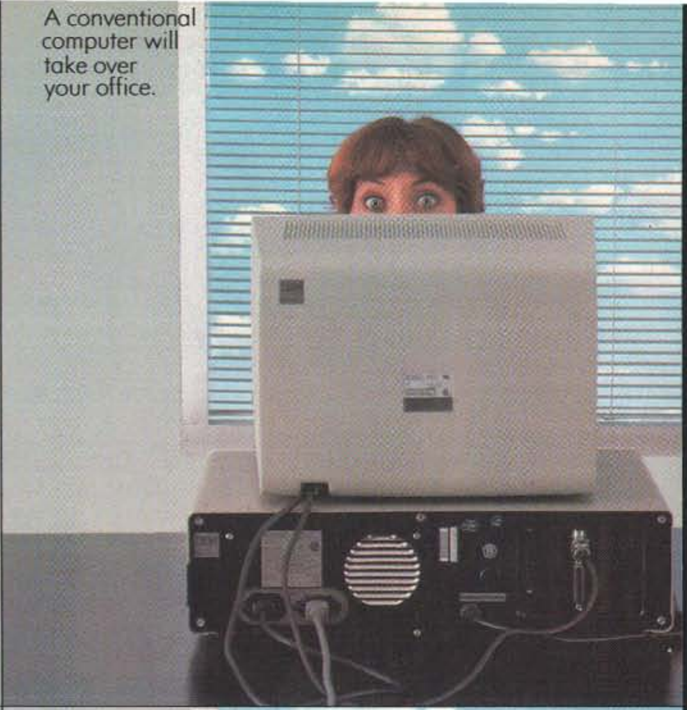
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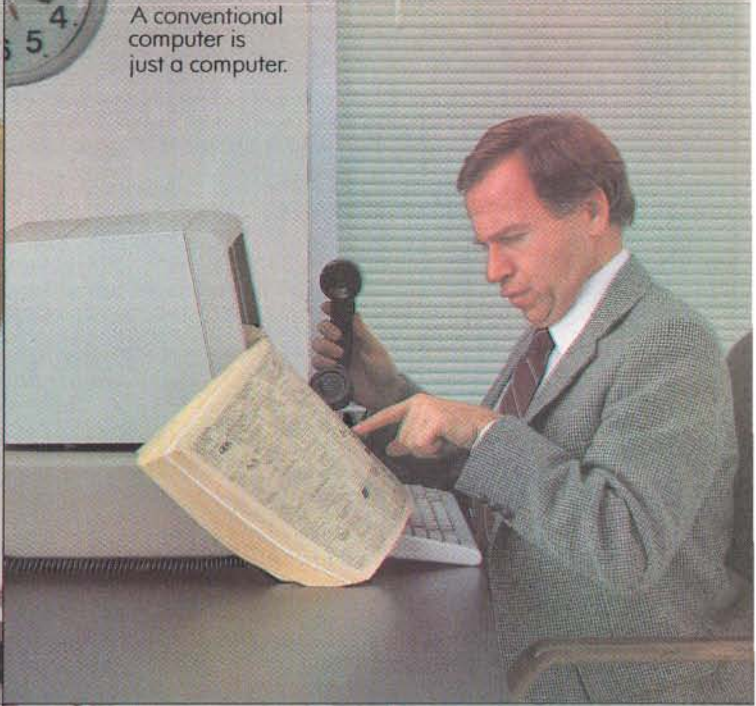
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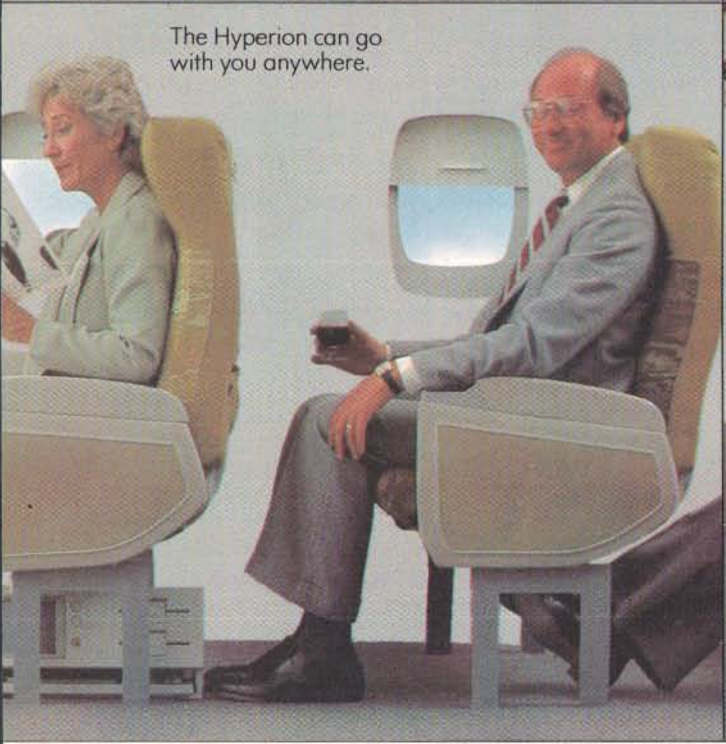
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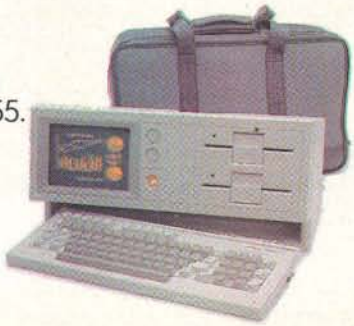

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with Write. For instance, he's figured out a way to reverse scrolling on the VT-100, which everyone told us wasn't possible, or at least not simple, since the VT-100 doesn't have an insert/delete line.

While I was at CP/M East, Charles Stevenson, chief programmer for Micropro, told me he's been having some problems with modern dot-matrix printers, because many of them don't do superscripts and subscripts by scrolling the paper up and down, but actually write little bitty letters and numbers in the appropriate places. Wordstar doesn't like that.

Neither did Write, but Noor Singh has found a way to make Write work fine with the new Epson FX-80 printer. We've now got Write on all the Kaypro machines, the Otrona, and the Z-100 (under CP/M-80). It runs with the Telewidget (Televideo) terminals, the Z-29, and the Lobo Max-80. Barry Workman and Noor Singh are installing it on the Osborne 1 and the Epson QX-10 (two versions, one for the Valdocs keyboard, the other for their nonstandard CP/M Teletype-layout keyboard). It runs on nearly all printers, serial and parallel.

Write will be supplied as part of the software package (along with Superwriter, Supercalc, and some other stuff) with new Compupro computers. Other versions, including those for older Compupro machines, will be marketed by Workman and Associates.

The Printer Install program will come with any version of Write that you buy. Workman's present market plan is to restrict the Terminal Install programs supplied, so if you order Write, be sure and tell the company what kind of machine and what kind of terminal you want Write for. I presume the company will have a reasonable policy regarding updates if a purchaser wants to change terminals.

Sweet-P

We got our Sweet-P plotter some time ago, along with a care package to make it work with the IBM PC. There was also a support pack for the Kaypro machines. Our Kaypro machines have been under intense use, and there wasn't any real reason to hang a plotter on one anyway. We did budget space for the Sweet-P at the desk where we intend to set up our IBM PC.

Alas, the PC hasn't arrived, and the Sweet-P sits in lonely splendor waiting for a computer.

That's a real pity, because the Sweet-P is one heck of a machine. There is close competition, but none so vigorously supported and advertised.

We were curious how hard the machine was to use; Alex got to play with one on a Kaypro at a graphics show. You can use LPRINT statements from within MBASIC to run the Sweet-P. For legends and titles, you don't have to specify each letter stroke; the plotter has a built-in character set. Character size and print direction can be changed, too.

Sweet-P has changeable pens; you have to change them yourself, but that keeps the price (of this model) down. Sweet-P currently connects as

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a Centronics printer; the serial option will be available soon. If you want to use both the plotter and your printer from the same Centronics port, Enter Computer will soon sell you a "Split-P" printer switch. (I get the feeling that we have not heard the last bad pun product name from these people. . . .)

More PC Stuff

Ada, for the tiny few who don't know, is the Department of Defense all-purpose computer language, and whatever its merits or lack thereof, knowing Ada is a sure guarantee of a job for years to come. Despite some claims to the contrary by companies that ought to know better, there is no complete Ada compiler for a micro system. However, there are healthy subsets up and running.

The best of these, for my money, is Janus Ada from RR Software. The company now has floating point for its PC-compatible version (both PC-DOS and CP/M-86 operating systems), provided that you have an 8087 chip in your system. RR has also cleaned up its documents a bit; they always were well organized.

I can't check out the latest version, since IBM has kept my money all these months without shipping me a machine; but I have run RR's earlier versions, which certainly work. Janus will compile itself, sure proof that you can write complex programs in this subset of Ada. I have high confidence in RR, and I have yet to hear of a more complete Ada compiler that will run on a microcomputer.

RR, otherwise known as Randy and Isaac, is another good example of what hard work and ingenuity can accomplish. The two started quite literally in a garage, and the West Coast Computer Faire was their first show; now they've about reached the takeoff point.

Simplifying My Life

I like small computers. I don't suppose there are too many readers who doubt that. However, they can sure use up a lot of time, and time is the one commodity we don't have mouldering piles of here at Chaos Manor, so I'm always looking for

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Table 1: *An example page from Jerry's index.*

ways to use these machines to buy me more time.

One thing that eats time is the telephone. It isn't just the time *on* the telephone; it's finding the messages and phone numbers and all the detritus from phone calls. I long ago learned that anything written on loose paper vanishes into the swim, so I keep a *bound* log book with page numbers.

One of the most valuable commodities a writer can have is a good idea. Those, too, get lost if not written down. I get some of my best ones while running, when I can't make notes, so I carry a tiny tape recorder and dictate; then when I get home I can transcribe those notes. I used to keep special books just for that, but it became impossible to find anything, so all that goes into the log with the phone calls.

So far, so good, but I use up two or three of those logs each year; and how the devil can I find a phone number, or an idea, from several years back? After about the hundredth time I found myself thumbing through old log books, I had an idea. What I needed was an index to the logs. It seemed a simple enough program to write.

The log books aren't machine-readable. I've had to go through them one at a time and enter the data (and I have to do it since no one else can interpret my cryptic notes); but it takes only about half an hour to do a whole book, and once done it's done forever. I have my index organized under three headings: "Major," "Minor," and "Subminor," which, if not original, is at least clear.

The output prints on paper (see table 1) and can be pasted into the front of the log book. It organizes the stuff in a hierarchy, with the Major headings (things like "Do," "Phone Numbers," "People," "Ideas") on the left. The Minor categories include "Programs" (under "Do," of course), people's names for the phones and addresses (with cross-entries for who they are or what they do or where I met them). Subminor is mostly notes. Then on the far right side of the index is the page.

Once the entries are made (as I said, about half an hour per log book), the program automatically sorts them, starting with the Subminor, then Minor, and finally Major headings, so that all the names are in alphabetical order within the "Phone" category, and that sort of thing. This gets printed and put in the book, and I can even do it periodically for the current log so I'm not always thumbing through it. Saves no end of time.

Another thing the index program does is remember just what log book this is: that is, 1983-1, 1979-3, etc. Another part of the program will combine index entries from different books. The result is that I have an enormous index that lets me find stuff running all the way back to 1978 when I began the log-book system (or will when I get through entering 1978 and 1979).

There's nothing all that wonderful about my scheme, and doubtless there are better ways to organize log books, but this works for me. The nice part is that the whole program didn't take more than a couple of hours to write. A story goes with that.

A long time ago I wrote a "Minimum Data Base" (MDB), which is a quick and dirty program for organizing telephone numbers, addresses, recipes, thoughts, characters in books, and the like. It has a good SORT routine built into it. When I decided to do this program, I realized that MDB had nearly all the mechanisms I needed for my index routine.

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MDB was originally written in CBASIC. I later converted it to CB-80, which was the first Compiled CBASIC; but since CB-80 won't run with CP/M 1.4, we kept the CBASIC version around. Alas, CBASIC doesn't have some of the nifty features that Compiled CBASIC does (such as checking for undeclared variables, and really good functions). Even so, we'd done a lot of the conversion, and when I did the index program I did some more. More important, though, when I began writing programs, MacLean insisted that I think about program structure as I wrote them; and although MDB isn't any model of structured programming, it's a heck of a lot more so than most old BASIC programs were, which is why I was able in one evening to write my index system.

Alas, it was while writing it that I discovered a real bug in the newest version of Compiled CBASIC.

That's Not a Bug, It's a Feature

When my late mad friend MacLean first talked me into trying my own programming in BASIC, one of the things that drove me nuts was the "redimensioned array error." That is: in early BASIC (and many late-model versions for that matter) you must tell the machine the size of any array, and you must do that one and only one time; any subsequent attempt to change the array size gets the error message.

When CBASIC, and later Compiled CBASIC (otherwise known as CB-80 and CB-86), first came out, a major feature was *dynamic array dimensioning,* i.e., you could dimension any array as often as you wanted to. There are lots of advantages to this. It saves memory and frustrations.

Of course, any data in the array will be lost if you redimension it. That's only to be expected. Alas, it isn't *automatically* lost; that is, if you have string variables stored in an array and redimension it, the strings are still out there in memory, only now there's no way to get at them, not even to erase them. Some versions of BASIC have a "garbage collection" feature, which is a little subprogram that every now and then goes through memory to see if there are lost strings it can erase to reclaim memory. Some don't.

With Compiled CBASIC, according to the instructions, you have to do something nonintuitive to get rid of those strings:

1. Declare a string variable. Say NULL$, for example.
2. Never define that variable. (I presume the default is "", but the documents never say.)
3. Set each element of the string array equal to NULL$.
4. Dimension the array to 0.
5. Redimension the array to the new value.

That's complicated, but you can see that it saves the compiler a lot of work. Alas, there's no way for you to get out of doing your part of that work. Compiled CBASIC has really excellent functions, comparable in some ways to Pascal functions and procedures, but you cannot pass an array to one of them as a parameter.

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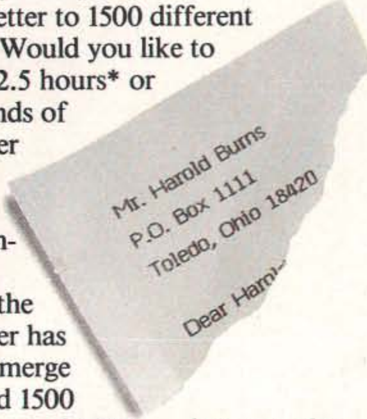
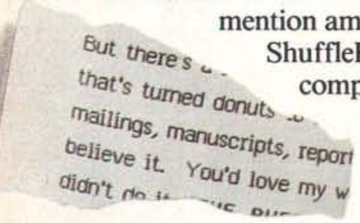


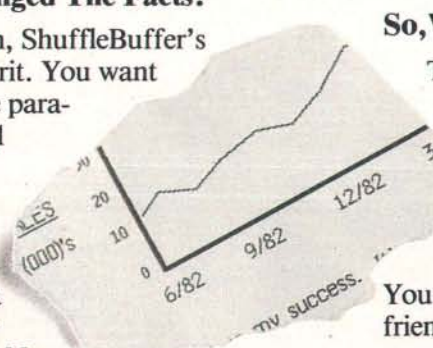
With a garden-variety buffer, the computer has to mix, merge and send 1500 addresses and 1500 letters to the buffer. Trouble is, most buffers only store about 32 letters. So after 32 letters, the computer's down until the printer's done. Altogether, you're talking 22.5 hours.

In the case of our new (not to mention amazing) ShuffleBuffer, computer time is 60 seconds flat. Just give ShuffleBuffer one form letter and your address list, and it takes care of the mixing, the merging, and the printing. But that's not all ShuffleBuffer's stolen from the computer. Oh, no.



Who Changed and Rearranged The Facts?

Again, ShuffleBuffer's the culprit. You want to move paragraph #1 down where #3 is? Want to add a chart or picture? No problem. No mystery, either. Any buffer can give you FIFO, basic first-in, first-out printing. And some buffers offer By-Pass; the ability to interrupt long jobs for short ones. But only ShuffleBuffer has what we call Random Access Printing — the brains to move stored information around on its way to the printer. Something only a computer could do before. Comes in especially handy if you do lots of printing. Or lengthy manuscripts. Or voluminous green and white spread sheets. And by the way, ShuffleBuffer does store up to 128K of information and gives you a By-Pass mode, too.



And Who Spilled The Beans 239 Times?

Most buffers can't tell the printer to duplicate. If they can, they only offer a start/stop switch, which means you're the one who has to count to 239. Turn your back on your buffer, and your printer might shoot out a room full of copies. ShuffleBuffer, however, *does* control quantity. Tell it the amount, and it counts the copies. By itself.

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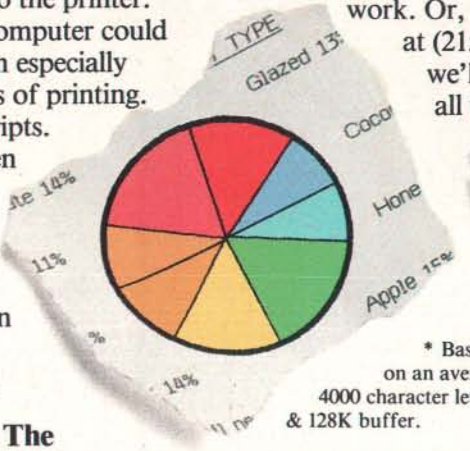

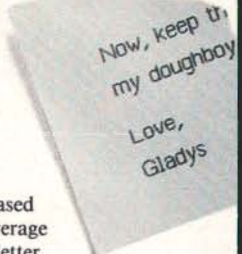

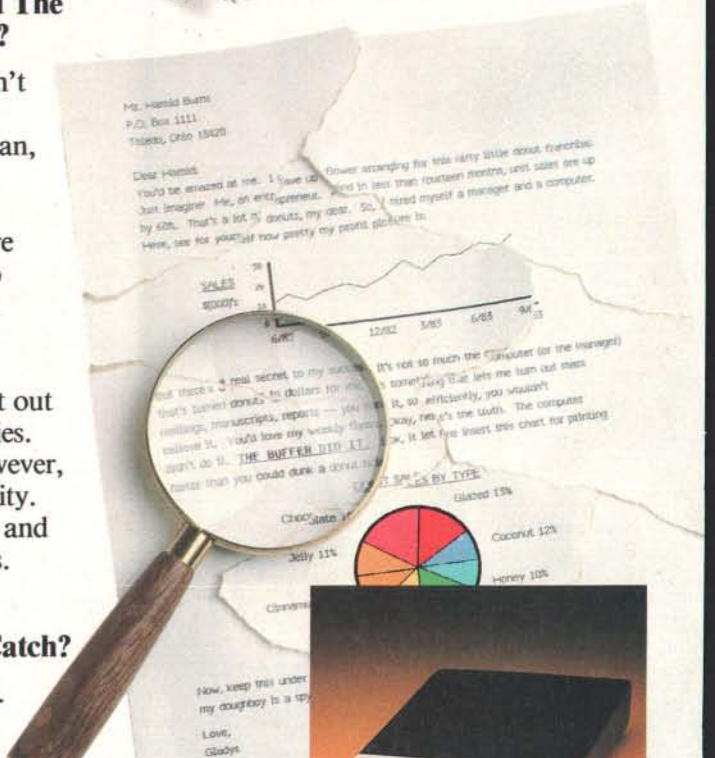

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If you could, it would be easy to write a "Kill String Array" function to do all that. Oh, well.

The problem comes when you forget and *never dimension the array in the first place.* Unlike Microsoft BASIC, CBASIC has no default array size. It doesn't even default to 0! The result is a terrible bug in your program.

If you leave an undimensioned array in a Compiled CBASIC program, the compiler won't find it. Your program will compile fine. It will run, too, until you try to do something with that array, at which point the whole system goes off into the land of lost bits. There's no error message. However, nothing whatever is happening, and nothing you can do (other than to reset the machine) has any effect. This can be frustrating, and indeed it took me half an hour to figure out what had gone wrong with a simple modification to my Minimum Data Base.

I suppose it's not too high a price to pay for dynamic redimensioning, but it's sure frustrating if you don't think of it.

Actually, it's worse than that. There's *no* range checking in Compiled CBASIC, meaning that if you exceed the boundaries of an array, you don't get the "Subscript out of Bounds" error you'd expect. It just hangs up the machine so that you have to reset. That *is* too high a price to pay.

Example:

```
REM A program to test arrays
Integer i,j
Real a(2)
Dim A(2,2)
FOR i = 1 TO 3
FOR j = 1 TO 2
  A(i,j) = i + j
  Print "Watch it crash"; A(i,j)
NEXT
NEXT
```

This will hang up as soon as the boundary of the array is exceeded. However, it hasn't told you *why*; it just stops the machine. This is enough to drive you crazy and is a real fault in Compiled CBASIC. Better you should use Modula-2, and I

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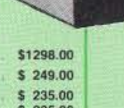

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intend to convert all my programs from CB-80 to Modula-2 as soon as possible.

JRT Pascal Yet Again

[**Editor's Note:** *Alas. At press time, BYTE was notified that JRT Systems (45 Camino Alto, Mill Valley, CA 94941) had filed for chapter 11 bankruptcy on November 18, 1983. This is not a complete liquidation, but a "reorganization." We thought the JRT delivery-problem saga had come to a conclusion in the April 1983 BYTE (see "Open Correspondence on JRT Pascal," Letters, page 18). Shortly thereafter, the number of complaints began to slow down—but scattered grousing continued. In any event, the slow delivery of the $29.95 software deal of the century most likely will be slowed down even more.*]

I'm getting weary of the accusation that I've said bad things about JRT Pascal because the BYTE advertising staff pressures me on behalf of publishers who charge a great deal more than JRT's $29.95.

For the record: I have *never* heard one word from the BYTE advertising staff suggesting that I make any modifications in my column whatever, and the only time the editorial staff asked me to change something was because they feared a lawsuit. On that one occasion, I modified one sentence, and even then I retained the substance of my remarks, changing only the tone. Blame me for my columns, or blast me for my opinions, but do not accuse me of petty cowardice.

I reviewed one of the 2.*x* versions of JRT Pascal, and I was not impressed. Since then I have received many letters from users concerning version 3.0, and the consensus is that if you can *get* version 3.0 you will like it.

Flat statement: JRT Pascal version 3.0 is a bargain at $29.95. Qualifications: it's a bargain in comparison to a lot of stuff on the market, and its value depends in good part on what you intend to do with it. If what you want is a fast-compiling nonstandard p-code language that works quite well and has no more anomalies than languages selling for 10 times the price, by all means send in your $29.95. You must then be prepared to wait, but the odds are reasonable that you'll eventually get more than your money's worth.

Indeed, as a language for writing real programs intended for the CP/M 2.*x* operating system, JRT Pascal is considerably better than "real" Pascal. If I had to write a number of reasonably sized programs, and I intended to stay with the CP/M 2.*x* operating system and not transfer the programs to anything else, I might well choose JRT Pascal as the language to write them in.

If I wanted to get some idea of the flavor of Pascal, and I didn't want to spend much money, I'd *certainly* get JRT Pascal 3.0.

JRT Pascal 3.0 has fixed most—not all, but most—of the bugs that plagued the earlier versions. As a programming language, it's comparable to Sorcim's Pascal/M in both ease of use and speed of compilation. The execution speed is comparable to any other p-code (intermediate code) Pascal, including UCSD Pascal. Like Pascal/M (but unlike UCSD Pascal), there's no integration of editor and compiler, but of the three, I'd about as soon use JRT Pascal as either of the others for production work.

The bugs that are left are, according to my correspondents, fairly harmless or very subtle. Since the professor who (in a letter praising JRT Pascal) spoke of the "subtle" bugs didn't tell me what they were, I can only guess at what he meant. One bug I found was a failure to compile a program because it had the following line:

```
{a comment} (*another comment*)
```

which was intended to illustrate the principle that you could use either kind of comment marker in a Pascal program. Standard Pascal (including both Pascal/M and Pascal/MT+) will compile that, since standard Pascal doesn't recognize physical lines.

There are other nonstandard features to JRT Pascal. For example, in the case above, the compiler didn't even attempt to work on the program; it simply told me there was an "unclosed comment." That is *not* a standard Pascal error message.

Another JRT problem can be caused by multilayed procedure nesting and indirect recursion. Most users won't find this a problem.

JRT Pascal does not format numbers in the same way as either Pascal/M or Pascal/MT+ (which don't format them the same way either). Thus, the same program will have a different output depending on which compiler you use.

I deliberately took out some semicolons in a JRT 3.0 program. The compiler dutifully reported "';' expected". Alas, the *standard* Pascal error messages are "Error #6 Illegal symbol (possibly missing ";" on line above)" and "Error #14 ';' expected (possibly on line above)." Perhaps the JRT error reporting system is *better* than Niklaus Wirth's, but it isn't the same.

JRT is worth playing with. It's cheap for the compiler alone, and you get a bunch of useful utilities with it. As I've said many times, I like the price, and I wish other publishers would drop their prices to something reasonable. JRT has a lot of satisfied users. Indeed, it may in many ways be more useful than "real" Pascal. However, that doesn't make JRT into standard Pascal.

In addition, JRT Systems got far more orders than it was geared up to fill. I have lots of letters from readers who ordered JRT Pascal and received nothing, neither software nor acknowledgment of order, for months. Sarah Smith, of Lisp Machine Inc., sent in an order in December, had the check cashed in January, got an acknowledgment of order in March, had them refuse to check the order in May, complained in June, and in August received a form letter stating that it couldn't find the order and wanted a copy of canceled check or bank-card bill. (The form letter offered to refund the money once proof of payment was furnished.)

Ms. Smith, like me, is a professional; the time it would take to get a copy of canceled check or bank-card bill would chop pretty deeply into the bargain value of JRT Pascal.

Thus, fair warning: JRT Pascal 3.0 works and has enthusiasts I respect. The manual is well written, and there

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are a lot of goodies that come with the program. However, if you order the program and don't get delivery, do *not* complain to BYTE or to me. Just be patient, and keep trying. Eventually you'll get satisfaction. At least you can continue to hope so.

I've heard that Mr. Tyson of JRT Systems is working on a Modula-2 compiler. I wish him well at it, but I do hope he'll pay more attention to the language standards than he did with his Pascal.

[Late addition: Borland's Turbo Pascal, for $49.95, is standard, produces native code (rather than p-code), and has a built-in editor. More next month, but it looks pretty good.]

BDS C

BDS C is a healthy subset of the C programming language. It uses some nonstandard library implementations; in that sense, it has some similarities to JRT Pascal.

The remarkable thing about BDS C was that it could be done at all; before Leor Zolman wrote his compiler, there was no C language for the 8085 or Z80 machines; at least, nothing that compiled in reasonable time and had most of the features of real C. Once Zolman showed that it could be done, a number of other outfits got into the act.

Zolman has a new version, 1.5*a*, of his C compiler. This one works only with CP/M 2.*x*; anyone still running CP/M 1.4 can't use it.

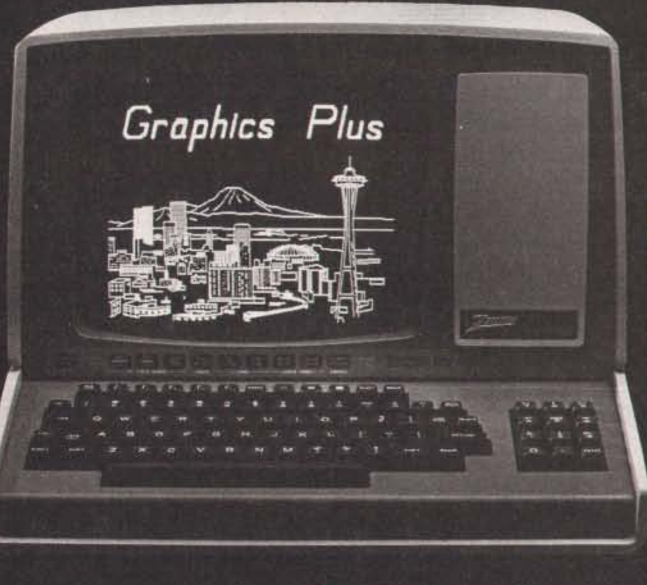
BDS C's major advantage is that it compiles faster than any other 8-bit C compiler and finds most trivial errors in seconds.

There is an improved floating-point package. Source code for most library routines is provided. The documents have been somewhat improved, but fair warning: the BDS C documents are not an introduction to the C language. You'll need both Kernighan and Ritchie (*The C Programming Language*) and some other good introductory book if you don't know how to use C.

There's a good index and a fair but improvable table of contents. The instructions for using BDS C, assuming you know something about programming in the C language, are clear.

BDS C's major advantage is that it compiles *fast*; faster than any other 8-bit C compiler. Furthermore, it finds most trivial errors in seconds. It's not the lowest-priced C compiler on the market, since Q/C is $99. At $130 postpaid (from Workman and Associates), though, it's still a bargain.

In addition, there's a debugger, a library manager, and other goodies. There's a good overlay or "swapping" system so that you can write and run really big programs in BDS C. BDS C purchasers are encouraged to join the BDS C User's Group; the User's Group distributes a lot of interesting



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All in all, BDS C is a reasonably priced way to get involved with the C programming language, or even to find out whether you really want to learn it. In my view, C is more useful on 16-bit machines, and I'm on record as saying I think Modula-2 is a more interesting language. On the other hand, a lot of people don't agree with me. You can certainly write some useful programs in BDS C; one of the most useful programs I own is a text comparator that one of Leor's friends wrote for me.

Once More, the Epson

When the Epson QX-10 computer first came out, the company was still evolving both hardware and software. I had a very early model, shipped long before Epson began selling the machines, and there was always some question of whether my system was truly integrated, especially when I had some real problems with the Valdocs software that comes with it.

The people at Epson couldn't have been nicer about it. The other day they sent out a systems-programming manager, who brought a new machine straight out of stock. We swapped.

I also have the new Valdocs software, version 1.18, which has a number of new features and is also considerably faster than the old Valdocs.

Alas, it doesn't have all the promised features of Valdocs, and apparently it retains some undocumented features as well. Moreover, although the new Valdocs is fast, it's not fast enough for me, my wife, or my assistant. In particular, it is *not* designed to be used as a substitute for an office machine. It simply takes too darned long to get a business letter out using Valdocs. Just getting the envelope addressed can take a full minute or longer.

Moreover, the FX-80 printer that came with the Epson QX-10 is not designed for use with letterhead or other single-sheet-feed paper. If you use a Micro Peripherals Printmate 99 printer with the Epson, that will solve one of the problems, but the Valdocs software doesn't know how to make use of the 99's best features, so that's not so useful either.

Valdocs might not be so bad if you use only tractor-feed paper, no letterhead, and you're mostly writing documents, not letters. It does have some good features, although you'd better get used to being patient.

We're at the moment installing Write on the Epson QX-10; we'll have versions for both the Valdocs and the regular Teletype-layout keyboards. Write will, of course, run under CP/M, not TPM and the Valdocs software, and it won't have all the cross-index features and other nifty conceptions Valdocs attempts. Our present version of Write probably won't be able to take advantage of the bit-mapped screen and other goodies that the QX-10 hardware features. We'll see.

Meanwhile, my opinion of the QX-10 remains: the hardware is fine, and if Epson ever gets software worthy of it, it will have a nice little machine. On the other hand, does the industry need yet another Z80 computer for more than $2500, especially if there's no software to take advantage of the unique hardware features of the QX-10? If Epson had released the QX-10 with appropriate software a year ago, it would have been competitive; I don't think it is now.

I've also seen no reason to change my opinion about Valdocs: noble idea, but too ambitious for the machine. To get all the features Valdocs offers, you need both a bit-mapped screen (which the QX-10 has) and a fast 16-bit or larger CPU (which the QX-10 doesn't have). I've a great deal of admiration for what was accomplished with Valdocs, but I cannot in good conscience recommend it to anyone who has actual production work to perform. It's just too darned slow.

There's one more difficulty.

Valdocs is slow in large part because Epson wanted it to be user-friendly; but alas, this wasn't even managed completely. If you get disk errors, Valdocs can report things like

```
Error 01 Disk B Retry Y/N?
```

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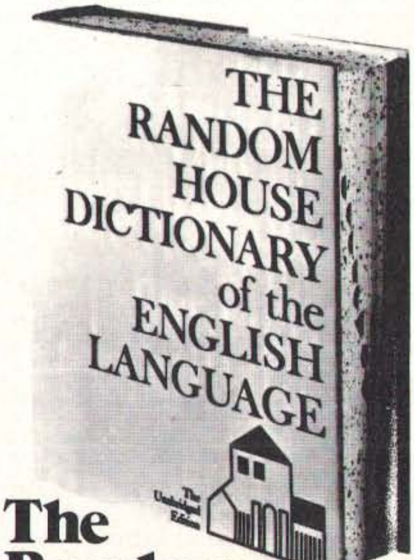

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and if you hold down the "Y" key very long, it will give the same message a number of times, since Valdocs features a large type-ahead buffer.

You can also get "Error FF" and other such cryptic messages. Now agreed: that's no more mysterious than the infamous "BDOS Error on B: Bad Sector" or such like; but it's certainly no less frightening to the naive user, and if you learn CP/M's error messages you've learned something about CP/M and other small machines. Learning what "Error FF" is teaches you nothing but Valdocs.

Conclusion: if you want yet another Z80 CP/M machine, the QX-10 will do, but there are probably better deals pricewise. The unique features of the QX-10 are implemented only in Valdocs, but alas, that's so slow that despite my encouraging him to use a computer (he has an Osborne at home), my editorial assistant prefers a Selectric typewriter for just getting the work done here.

I like the bit-mapped screen, which lets boldface words appear on the screen in boldface (as well as on the output copy), and I like a lot of the other features of the QX-10; if Epson ever gets software worthy of the machine, it'll have something really great.

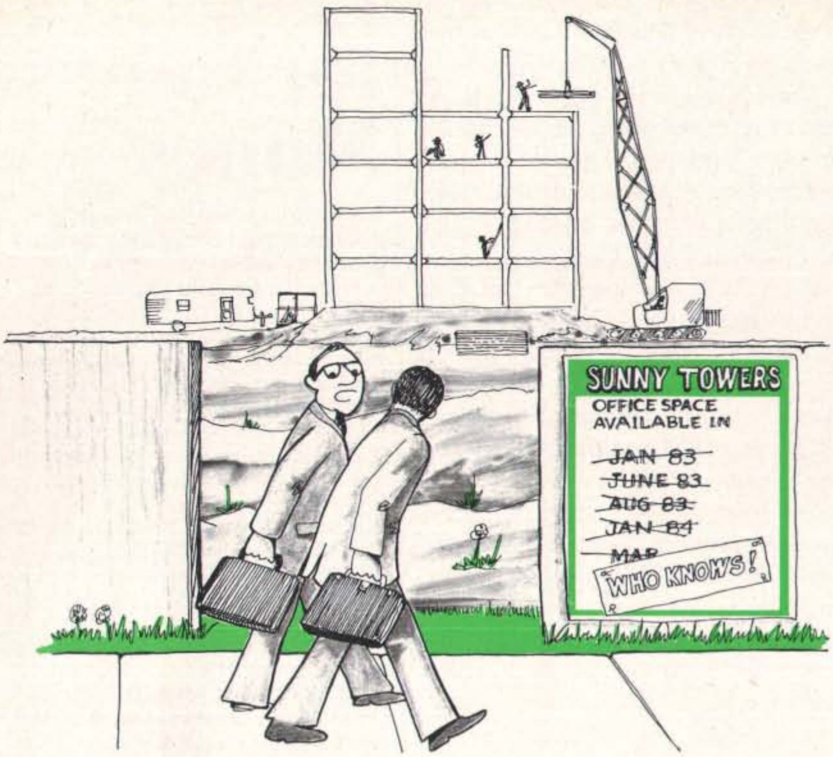
As of October 1983, it doesn't.

Rana

If this were a news column, this item would have to be the lead. Alas, by the time you read this in January others will have printed it first.

Not long ago I went out to Rana, an outfit that makes really advanced disk drives for popular machines like the Apple and the Atari. I brought home some of the drives, which we installed on our Apple and Atari machines, and waited for the boys to report, since those are their machines and they're out in back where I don't see them often.

Their report is wild enthusiasm. Don't get standard Apple drives. Get Rana's package, which includes a new disk-controller card and a whole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Epson QX-10 $2995
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Janus/Ada D-Pak 8080 $500
RR Software 8086 $700
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(608) 244-6436

JRT Pascal $29.95
JRT Systems
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Mill Valley, CA 94941
(415) 388-0530

Turbo Pascal $49.95
Borland International
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Scotts Valley, CA 95066
(408) 438-8400

Rana Disk Drives Elite 1 (Apple) $379
Rana Systems 1000 (Atari) $449
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Chatsworth, CA 91311
(213) 709-5484

Repton $39.95
Spider City $39.95
Sirius Software Inc.
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Sacramento, CA 95827
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Slicer Computer $1075
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Write $239
Minimum Data Base $49.50
BDS C $130
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bunch of stuff. It all works faster than standard Apple, with fewer loading errors. It works with the Applicard CP/M converter card, too.

We never had any other disk drive for the Atari, but I can testify that the Rana Atari drive works flawlessly on our Atari 800, loading Repton and Tank Attack and other games (on which more another time) and reporting all kinds of information that the Atari standard drives don't.

However, I'd have waited for a less exciting month to write all that, disk drives for my popular computers not being my major area of interest, if the Rana people hadn't showed me what they're up to out there, which is no less than the demise of the hard disk.

Rana will very shortly sell you a 5¼-inch floppy disk that holds 2.5 *megabytes* formatted.

That's a *lot*. Syquest will for $90 or so sell you a "hard-disk cartridge" system that holds 5 megabytes. Rana's system requires preformatted disks, but the disks will sell for $15 at first, less later, so that expense is hardly a problem.

The Rana system puts "burst tones" on either side of the data tracks on the disk. These tell the disk head precisely where the track is, meaning the track can be narrower, and the tracks can be closer together, so that distortions of the media won't give you bad sector errors. If you want to know more about the technology, read something

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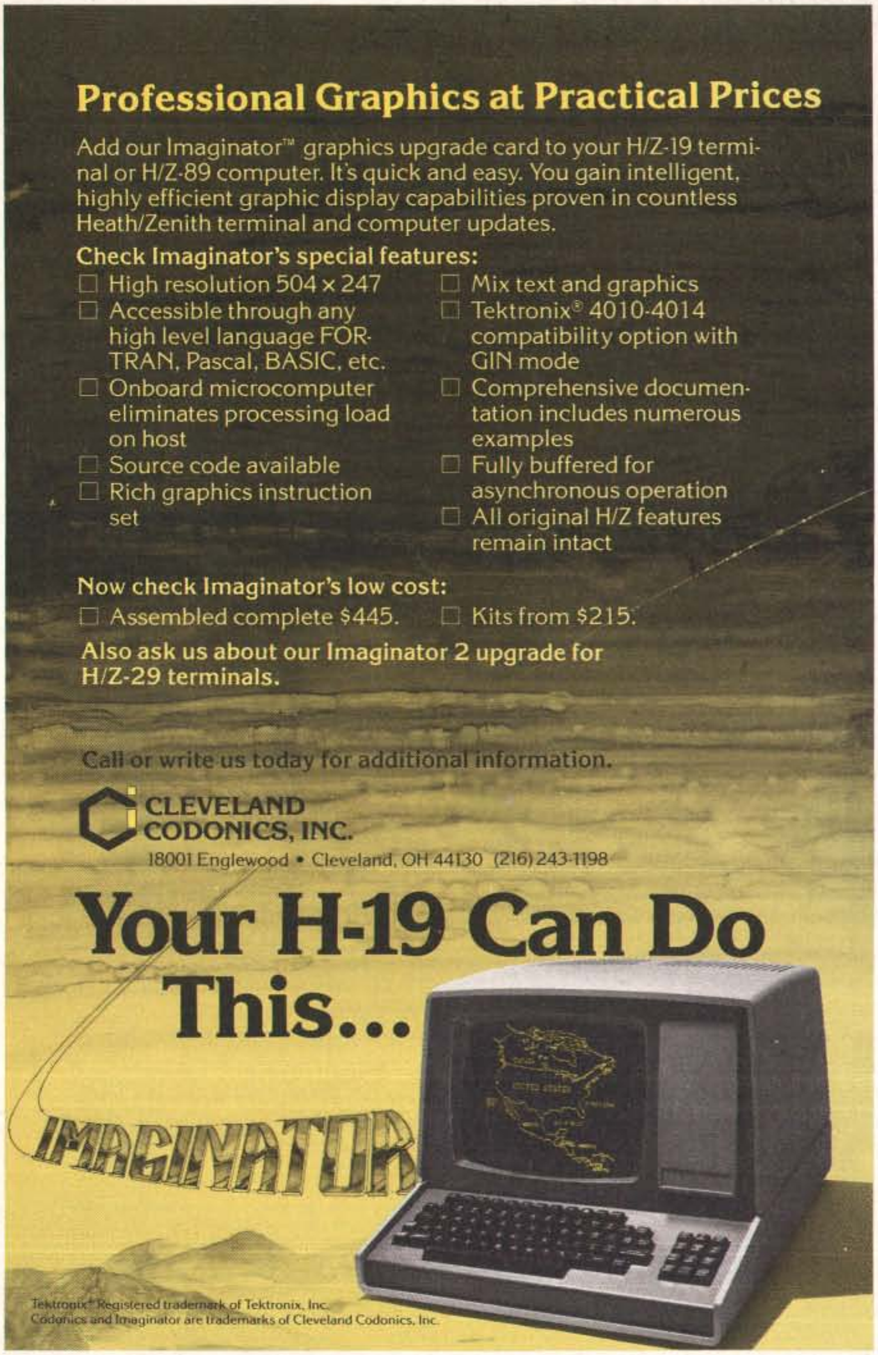
technical; I'm more interested in the implications.

RAM disk, i.e., a way to fool your system into thinking a lot of memory is a disk drive, is becoming standard on most advanced systems like Sage and Compupro and will be standard on all systems in a few years. Pion's Interstellar Drive and Semidisk already offer ways to put battery backup on your RAM disk, making it pretty secure; once again, that will be standard one of these days.

With a megabyte of RAM disk and floppy disks holding 2.5 megabytes, many of the advantages of Winchester hard disks simply go away. After all, hard disks are not as reliable as floppies. They are subject to problems when there are extreme humidity variations. They don't like shock and vibration. They have to be "backed up," which is to say you want copies of what's on them, and that takes time and has to be done. Their major advantages are speed and lots of storage.

I don't make it as a flat prediction, but I do put it as a subject for thought. Given lots of RAM disk, and 2.5-megabyte floppies, is there really a need for hard disks at all? However that develops, Rana is a company worth watching.



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Time Eaters . . .

I'm not very good at arcade games. My timing just isn't that good. Consequently, I prefer games of strategy to joystick shoot-the-enemy games.

My boys, however, have different preferences. The other day an enormous package of Atari games arrived from Sirius, and since then we've had trouble getting them to come in for dinner. There's no room to report on all of them; I'll get to them next month.

Meanwhile, my own favorite is the Atari version of Repton. I didn't much care for that one on the Apple, but I find myself wasting more time than I should on the Atari version. There's also Spider City, which is mostly shoot- 'em-up but does have some strategic decisions involved.

My all-time favorite, though, is still Epyx's Crush, Crumble, and Chomp. There's something exceedingly attractive about burning down and stomping the Pentagon flat, and in general making an even bigger mess of Washington than the politicians have. . . .

Sigh

My notebook contains six or eight other items I ought to have got to, but I'm out of space. I'm also out of time, since I've got another speech to give tomorrow and my plane leaves in an hour.

I love this world of little machines, but it can wear you thin.■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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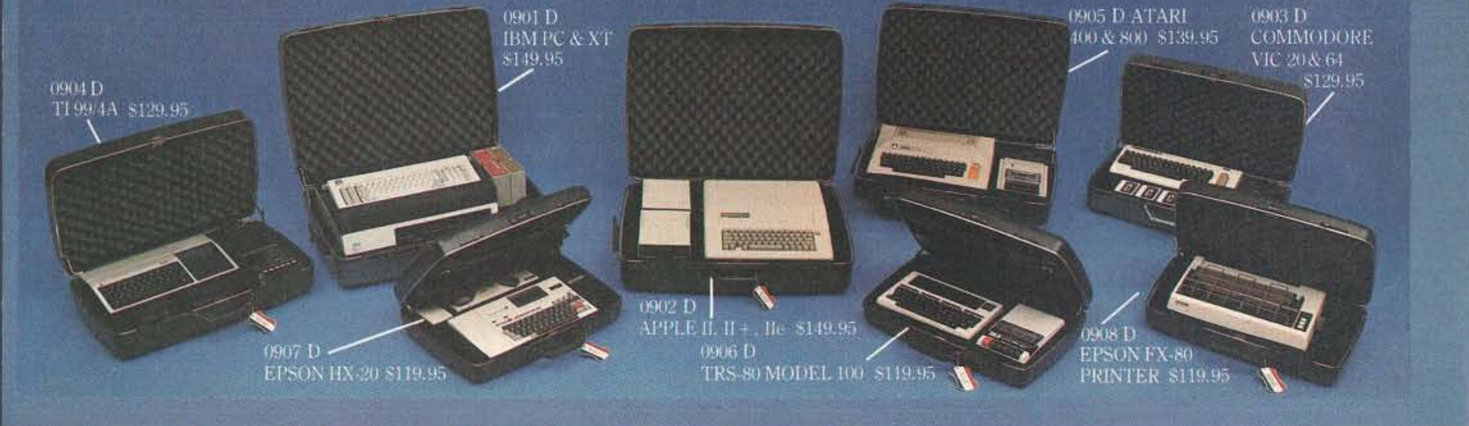

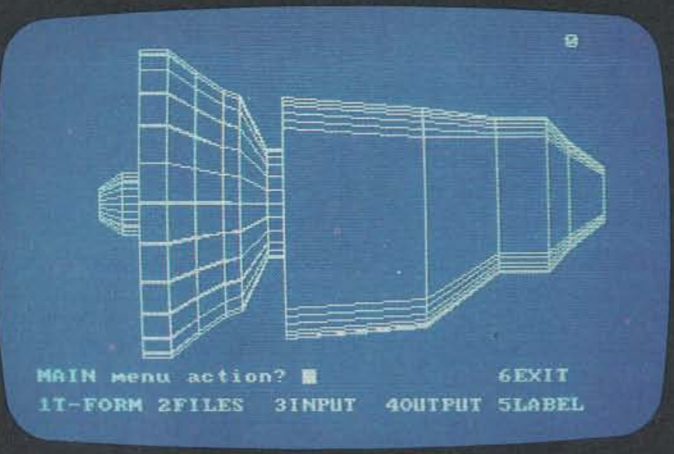

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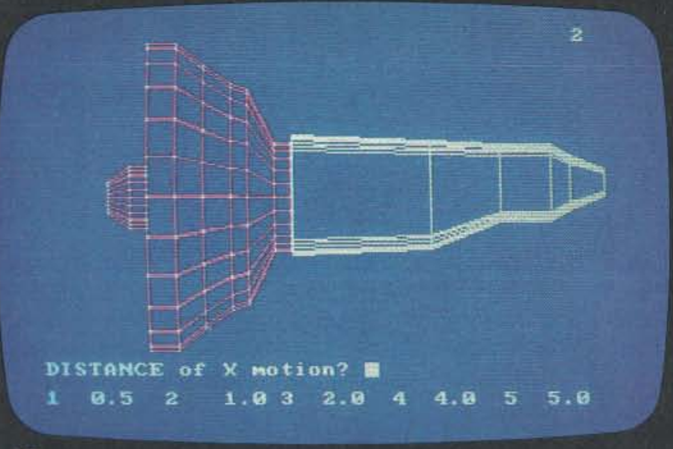

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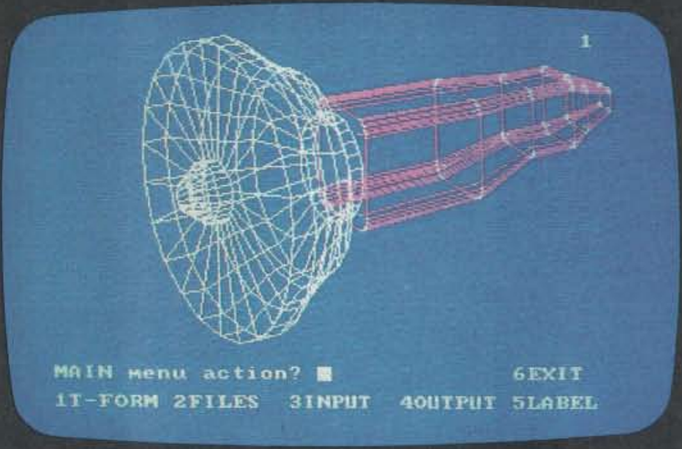

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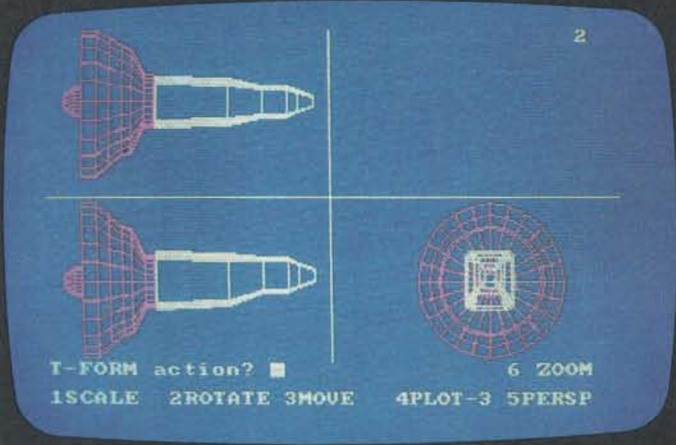

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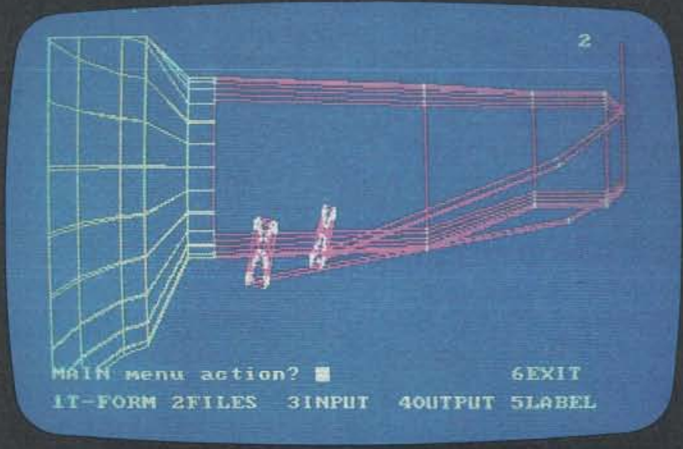
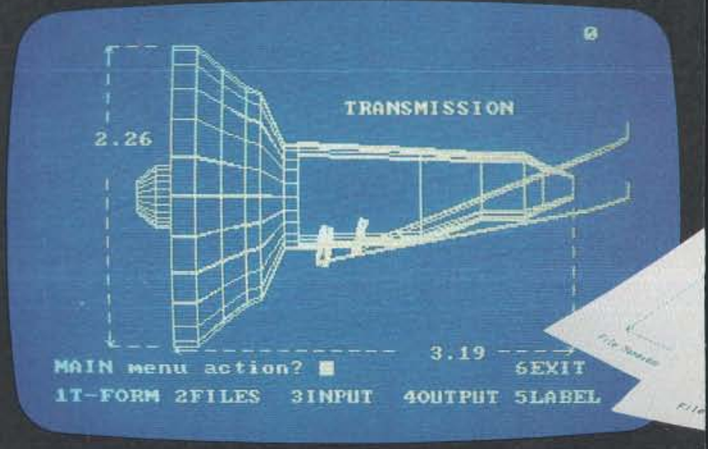


5 Zoom in on part of it and add details.



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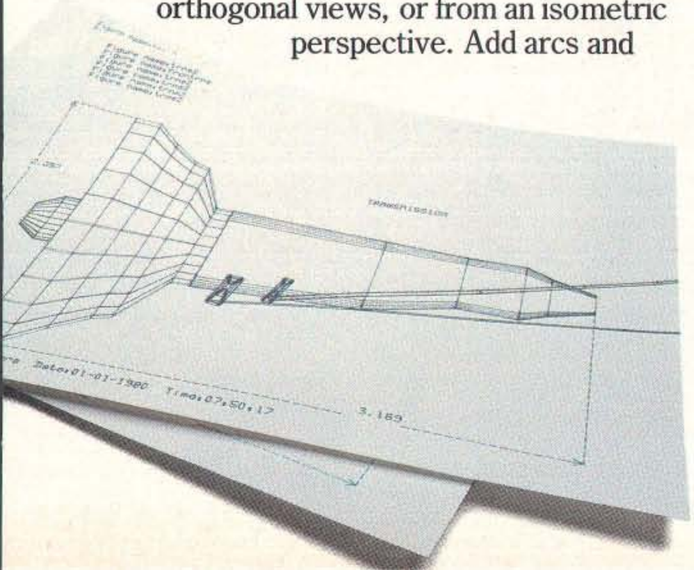

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1984 and Beyond

"Under the spreading chestnut tree
I sold you and you sold me;
There lie they, and here lie we
Under the spreading chestnut tree."
—George Orwell, *1984*

1984. Just another year? Or the dawn of a sinister new era, an era of individual paranoia and cultural stagnation born of fear and suspicion? A time when people's movements, habits, and thoughts are monitored by a centralized power that possesses the technology to gather, record, and collate mountains of data?

Or could 1984 bring the beginning of a Pax Orbis Terrarum of prosperity made possible by a technology that places power in the hands of virtually all citizens, an information autocracy that closes communications gaps and binds knowledge workers into a diverse but cohesive community?

These are complex questions that may have no answers. Despite our thematic cover, this issue of BYTE makes no attempt to examine the social, psychological, and political impact of microcomputer technology—after all, this is a technical journal.

Instead, as is our editorial wont at the turn of each new year, this issue offers some speculation on the specific technical innovations that will affect the personal computer industry in 1984—32-bit microprocessors, natural-language systems, credit-card-sized memory devices, and others.

Before delving into these matters, however, we may all do well to reflect on the implications of our headlong assault on the bounds of technological possibility.

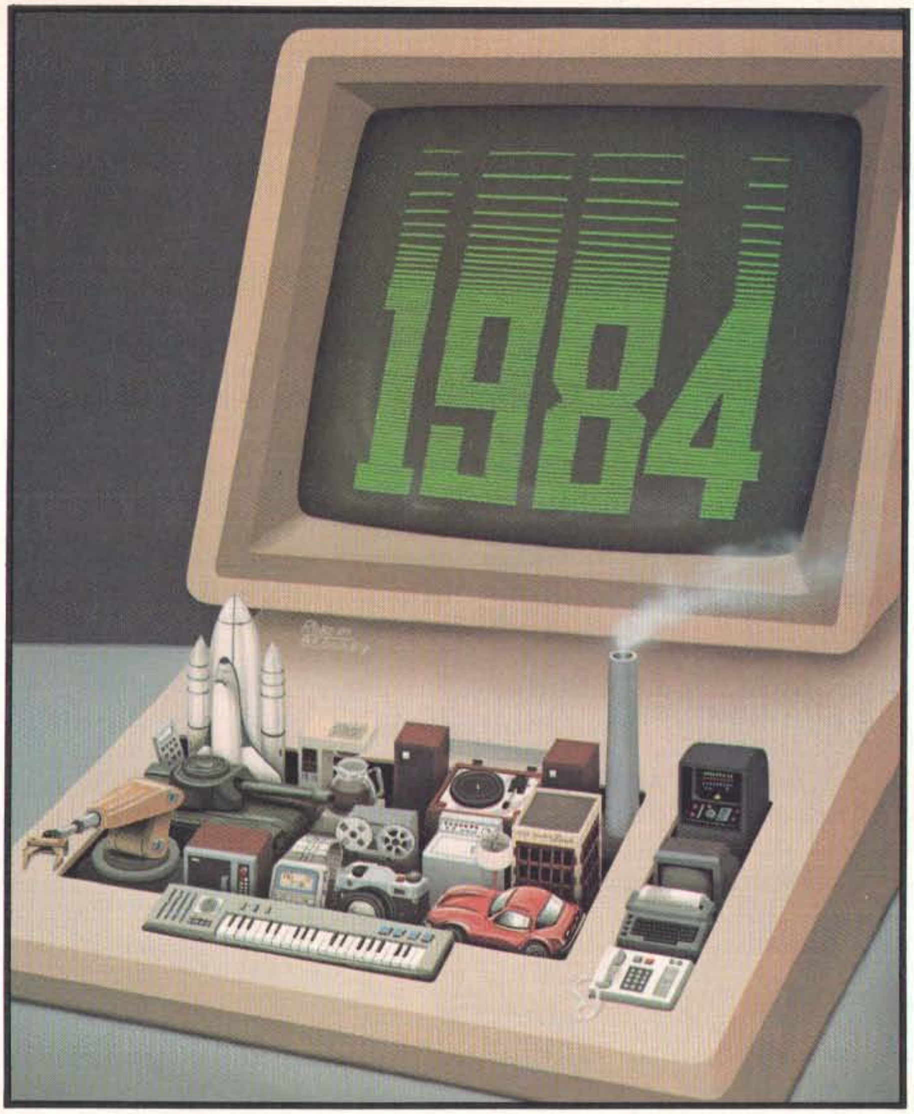
Eric Blair, writing under the pen name George Orwell, created in 1947-48 his "negative Utopian" vision of a world dominated by fascists who possessed awesome technology. The real world was trying to cope with the aftermath of an unprecedentedly destructive war, with the ugliness of Hitlerian genocide, with the throat-clogging fear of the power of nuclear war technology. In this atmosphere, Blair, a fanatical anticommunist, chose to warn the world of the peril represented by the emerging Russian state by conjuring up the vision that is *1984.*

The reality of the current world is not nearly so bleak. Nevertheless, there are legitimate concerns about the use of computer technology in modern society. While there may be no Big Brother inside your personal computer, the fabric of life in the West is strongly tied to this technology.

In fact, as this month's cover by visionary Robert Tinney depicts, Western society is heavily dependent on computer technology—it makes possible the telecommunications system that drives our complicated commercial and industrial economy and permeates all its sectors. As a society, we are addicted to computers in much the same way that we are addicted to petrochemicals.

Any dependency can be exploited. Our culture's computer (and information) dependency can be used against individuals and groups as easily as it can be used for them. The negative uses of information have been documented by writers such as David Burnham in his comprehensive book *The Rise of the Computer State.*

The government is a major user of information. The most extensively shared information pool in the world



Painting by Robert Tinney

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is the FBI-coordinated National Crime Information Center, a computerized network linking more than 57,000 local, state, and federal law-enforcement agencies. The IRS is another agency keen to collect and sift information. Its latest efforts include buying the mailing lists of swank department stores and luxury-car dealerships to track the buying habits of well-heeled taxpayers (*Fortune,* September 8, 1983).

As Kent Greenwalt of Columbia University Law School suggests, intensive information gathering could produce a nation of sheep, all trying to keep their records clean. Such a response could sap the vitality and diversity of our culture.

With the advent of home banking and shopping services, virtually every financial transaction we make will become part of a computer-controlled record. As the text box on page 102 suggests, unauthorized use of these databases may be impossible to prevent. The information society may soon be victimized by a new class of criminal, the information thief.

Currently, no laws prevent the use of information intercepted during data transmission over telephone lines. While tapping phone lines is illegal, using the information garnered from a tap is not. The sender virtually relinquishes his ownership of computerized information by the mere act of telephone transmission. This presents the specter of thieves intercepting information transmitted from a bank computer to your personal computer and using the information to empty your account.

In the face of these gloomy possibilities, though, is the bright prospect that personal computers also have many beneficial aspects. They can have a democratizing influence on society by making access to information available to large numbers of people. They can aid communication among groups and individuals, further shrinking the distances separating the people of the global community.

However computers ultimately affect our personal and public lives, you, the BYTE reader, will be one of the first to know. Theme issues planned for 1984 will cover topics such as data security, mass storage systems, new chip technology, and communications.

—G. Michael Vose

Does Your Computer Need "Debugging"?

by Bruce Bierman

You are in your private office sitting behind your microcomputer, transmitting highly classified data to another computer system. There is no reason for you to suspect that the information you are sending is being intercepted. Nevertheless, today's electronic eavesdropping devices make stealing your precious data a simple operation. The interception may occur during data transmission, when floppy disks are being mailed, as a result of illegal access of a mainframe using a micro, or because an ex-employee knows the password to your system. But no matter how it occurs, unless you are aware of the vulnerability of your computer system, you leave your data open to a new class of criminal-information thieves.

Computers connected to telephone lines are especially vulnerable. Data transmitted from computer to computer can be intercepted. Most computers used to send data to another computer can be called by an unauthorized "hacker." Once an intruder gains access to the computer, he or she breaks past the password level by writing a computer program that generates possible combinations of characters until the password is found. Another method finds the "back door" access left behind by the original programmer—à la *WarGames*—but this is not usually the case. Once the password has been found, the intruder has total access to the computer system.

Dialing into a remote computer using a modem and a terminal or another computer enables a user to gain complete access to that system.

Computer data transmitted on telephone lines can also be recorded using wiretapping devices. The recordings can be input into another computer for decoding, allowing the thief to read your information. This vulnerability also applies to Facsimile Transmission Machines (FAX), which send pictures of documents over telephone lines. A tap on a FAX line is the equivalent of an outside individual having access to your documents and a copy machine.

I have personally been involved in tracking down information leaks from a major computer company whose coming years' marketing plans and price lists turned up in a competitor's office. The recording of a PanaFax telephone data-transmission line between the U.S. and Japan proved to be the source of the leak.

Transmitted computer data is made up of erratic sound patterns. Therein lies a legal loophole—currently, no laws protect the interception and recording of these sound patterns. The law does protect an individual's privacy in a telephone conversation, but not the individual's transmitted data.

Using sophisticated electronic eavesdropping devices, recorded ASCII (American National Standard Code for Information Interchange) transmissions can easily be decoded to text on a printer. There are programs available on the market that absorb strings of data recorded on tape and analyze the nature of the data format. The program can determine if the data is ASCII or an encoded or encrypted file. After establishing the type of file, it creates a program to read and print the information.

Although there are devices that protect large computers from unauthorized access by using a call-back verification method, these devices can be defeated. Establishing where the authorized locations of dial-back are and diverting the call-back to another location using an array of available telecommunications equipment on the market is one method. Even if an individual cannot break into the system using his own micro, there are still ways to intercept the transmitted information by placing devices on the data line or within the computer system itself to monitor its operation. This is called "bugging" a computer, which is quite different from a computer with bugs. In bugging or tapping a computer, you can set up the appropriate access necessary to monitor the system's operation using a microcomputer with a program that logs all the functions taking place.

The detection method for finding these back doors, or "debugging," is quite different from correcting errors in a system. This type of debugging demands that all logical paths are defined to establish their finite termination points within the system. Software taps can take a long time to find, while hardware taps are more visible and take much less time to identify.

It may be possible to prevent access to your computer system by hackers or pirates, but a great deal of high-tech espionage is still possible. The professional thief will not spend hours and days figuring out passwords and back doors when he can simply place a tap on your telephone line. All he has to do then is sit back and wait for you to begin transmitting data.

Bruce Bierman is president of Communical Inc. (1400 Grant Ave., Novato, CA 94947), a computer-security consultant firm.

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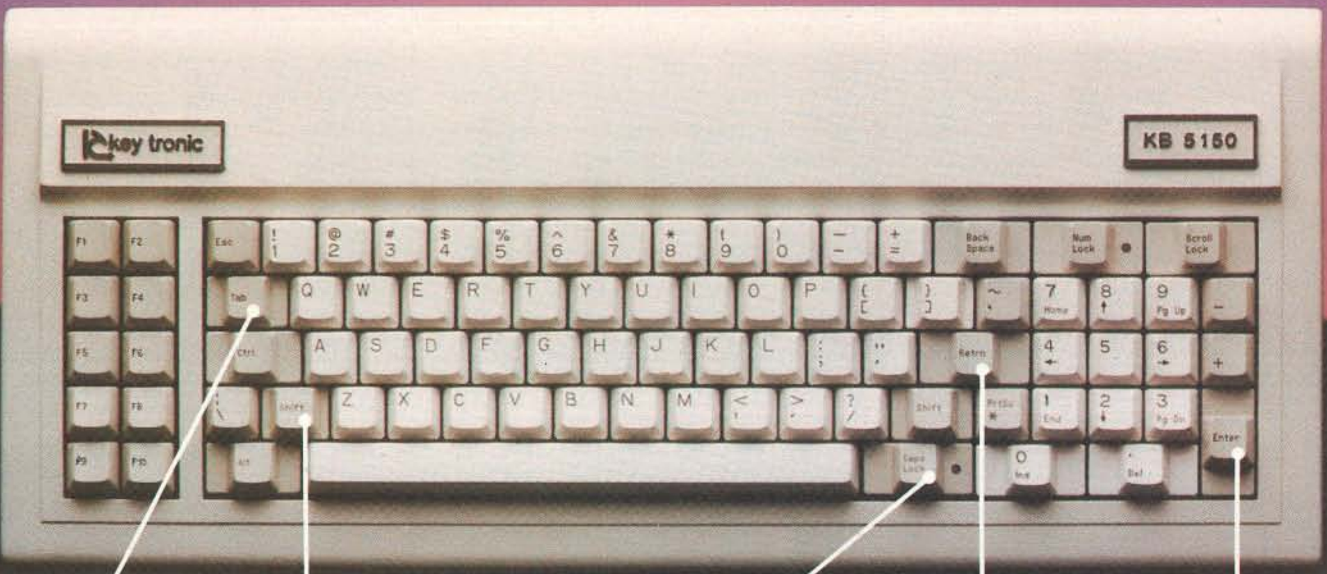

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Reason and the Software Bus

A narrative about future software

by Michael F. Korns

With the dawn of 1984, a look into the state of software production provides a view of contrasting extremes. At one extreme are advanced software projects, including the Japanese ten-year project in supercomputers and intelligent software. In this world, heavily funded software research facilities produce expert systems, natural-language interfaces, advanced CAD/CAM (computer-aided design/computer-aided manufacturing) software, and more.

At the other extreme lies the world of day-to-day business and industrial programming, a world where 60 percent of all software is still written in assembly language. In this world, armies of software technicians labor intensively to produce small advantages, and a request to a corporate data-processing department for a simple report may be bottlenecked for two years.

What is the future of the software industry? Will more intelligent software put the less competitive software factories out of business? Will the COBOL programmer become an extinct species? Indeed, will all applications programmers be replaced by automated programming software? As artificial-intelligence techniques permeate computer science, the answer to each of these questions may be yes.

The Reason Research Project

In the summer of 1981 I began a research project in artificial intelligence. Its long-term goal was to develop a highly intelligent software system. I wanted the system to be as independent of its supporting hardware as possible and also to be easily portable to succeeding generations of computers, to take advantage of increases in processing power, speed, and memory-addressing range. I called the project the Reason research project.

As the project gained momentum, I took on an assistant. Our first two years of effort resulted in a new software technology—the Reason software bus—and an advanced software environment that provides multiple windows and tasks. We call this environment—as an in-house joke and with all due respect to Visicorp's Visi On and Apple's Lisa—Lision. This article describes the work of the Reason research project and its possible effect on future systems software.

Before I describe the Reason software bus and Lision, I'd like to review the research background of the project.

A Large-Scale Technology

Because of the project's ambitious goals, I knew it would involve many lines of code and intricate algorithms. To have a hope of success, I had to begin by thinking at industrial levels: not a few programs and hundreds of lines of code, but hundreds of programs and thousands of lines of code.

In software engineering, techniques that are effective at low levels of production may not remain so at high levels. Selecting the correct technology base for development and production was an important challenge.

Possible System Models

In choosing a technology for our software, I considered various currently available choices including tools like Unix, C, Pascal, and Modula-1 as well as structured-programming techniques, function-oriented languages, and object-oriented operating systems. I even reviewed current experiments that vary from von Neumann's stored-program, register-based model of computing hardware design toward increasingly parallel processing techniques.

Ultimately, we reduced the field to three contenders: object-oriented operating systems, function-oriented languages, and a new model—a "software bus."

Object-oriented operating systems and function-oriented languages are based on systems theory and algebra, respectively, and both derive from sound theoretic origins. Each of these orientations can be applied at some level of engineering effort.

However, important questions remain. What are the costs of implementing these systems, and what resources will they consume in order to operate efficiently?

Ultimately, I chose to use the third system model, the software bus, as the basic tool for the Reason research project. As we will see in a moment, this model springs from an extremely successful engineering metaphor, rather than from algebra or systems theory. I thus began with a system model that I guessed would be practical, without first worrying if the model could be shown to be complete in the mathematical or theoretical sense.

The Hardware Bus

It was the impact of the hardware bus on the recent history of computers that made me think a software

Artificial Intelligence: Reason's Generational Approach

The standard approach to a project with the scope of Reason requires many programmers and much money. We did not have such resources and did not wish to seek venture-capital funding. For these reasons, we took a risky approach to reaching our ultimate goals. We had to bootstrap not just our efforts, but the technology itself.

We chose to build the Reason technology in generations of tools. The idea was that each new generation would be more powerful and efficient than the previous one, taking us a step closer to our goals, and that with each generation we would build the next.

This strategy was very risky because if even one generation of tools should fail, the project's overall success would be cast into doubt.

The systems and tools described in the main text represent the first generation of the project—the Reason software bus. This generation of tools is not intended to take up directly the question of artificial intelligence. Instead, these tools greatly accelerate the creation of more powerful program components.

Using these tools, the Reason research project has been able to generate a complex software system quickly. The tools seem to be more efficient than anything any of us involved in the project has used before.

We also feel that the Reason software bus fulfills the other criterion of each generation of our technology: to represent a small but significant step toward the project's long-term goal of artificial intelligence in software. How do I mean this?

No system, human or machine, can achieve advanced intelligence unless the system can manipulate its own components. To do this, the system must have a model to use as a guide. If the system is a machine, the model must be simple and clear enough for a program to understand.

These criteria were crucial in deciding that the software bus was the most appropriate model to use for the first generation of our project. The Reason software bus is a simple, packet-switching data-transmission protocol. In addition to fulfilling this generation's goal of greatly increased programming productivity, it is also a model simple and clear enough for a program to understand. The next generation of integrated components running on the bus may well address directly the issue of the ability of the Reason software bus to understand its own model.

bus would be practical. Bused hardware designs, using integrated circuits, have been extremely effective in advancing electronic engineering in recent years. Most microcomputers, for example, include a hardware bus as an integral part of their design.

The bus setup enables engineers to design such computer systems in an open-ended fashion. Simply by making them conform to the hardware bus protocol, engineers can create exciting new hardware and peripherals compatible with existing systems. Other engineers can configure new and different systems out of existing chips and integrated circuits. Field technicians can repair all these products by replacing modular boards.

Telecommunications systems display another successful application of busing protocols. Communications networks, which bus data from one location to another in small packets, are indispensable to today's information-processing industry.

The Reason Software Bus

The power of the bus as a system model is all the more remarkable in that the bus is little more than a data-transmission protocol. What interested the members of the Reason research project was whether this busing concept could form the basis for a similarly successful generation of software tools. Could we apply the same design metaphor, so successful in hardware and telecommunications, to the creation of an equally successful new software technology?

The Reason software bus uses the bus metaphor to create a new software technology. In its basic form, the software bus is a simple protocol for transmitting data packets from one bus-integrated software component to another. The bus protocol looks like a standard telecommunications protocol, with six transmitted parameters and two returned parameters.

Bus-integrated components are independent software modules, the metaphorical counterparts of the integrated circuits in a hardware bus design. They are passive software packages, activated by transmissions along the software bus.

Once activated, a bus-integrated component may initiate transmissions that activate other bus-integrated components. In such an orientation, the software implementing the bus is in control. Individual software components are not even aware of a world outside themselves. Instead, they simply receive and transmit data packets from origins to destinations.

Power and Flexibility

Like their counterparts working in hardware-bus environments, Reason design engineers using the software bus can develop powerful bus-integrated components, confident that Reason *system* engineers can quickly configure the bus with various combinations of these components to create complex applications systems. Reason maintenance personnel can repair or update such systems merely by replacing one or more bus-integrated components with newer and more powerful components.

Reason and Unix

A comparison with Unix illustrates the power and flexibility of a software-bus design. The Unix operating system allows standard output from one program to be rerouted as the standard input to another program. This capability, called piping, is a hallmark of Unix flexibility.

Now consider an environment in which *all* input and output of *any*

System Models in Software

Why can't you request a list of all the programs that operate under CP/M? Of the programs that interact with each other? Of the means they use to interact?

Because no such list exists, nor is it likely to exist soon. This is because the system model for CP/M programs is unclear. People can and do write CP/M programs in any fashion they choose. The question of system modeling comes up only after the programs are written, when it is too late. CP/M is just one of many programming environments in which the system model does not receive high priority.

However, new programming environments are being designed in a different way. Designers choose a system model first, and then create programs.

We considered three such models for Reason. Object-oriented environments, function-oriented environments, and software-busing environments.

A number of current experiments are aimed at developing object-oriented computer operating environments. An "object" can be anything from a byte memory switch to a whole suite of programs, depending on the flexibility of the system's "object dictionary." Object-oriented environments depend heavily on descriptive tables and dictionaries.

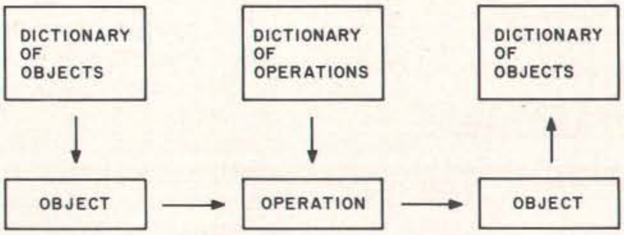


Figure 1: *An object-oriented operating system model.*

The preliminary manual of one such project contains terms like hierarchy, node, keys, locks, badges, and zone-in-item-space. More simply, however, figure 1 illustrates the kind of model an object-oriented operating system proposes.

In this environment, operations performed on objects create new or altered objects. Each of these objects and operations is stored in one or more dictionaries. As operations alter objects in the environment, the environment's dictionaries are updated to reflect these changes. Thus, a list of available programs, which was difficult to obtain for CP/M, is easily obtained in an object-oriented environment. You simply examine the system's dictionaries.

Function-oriented programming environments extend to the design and construction of new programming languages and to the future of computing hardware. Function-oriented environments are especially exciting when designed in tandem with hardware design.

In such an environment, the function-oriented software is designed to break large functions down into sequences of smaller functions. The software then ships these smaller functions to parallel processors so that the various portions of a problem are solved piecemeal but simultaneously.

The Reason design team did not choose either of these models, despite their respective attractions. Instead, we chose to develop a software bus. Although it was a newer, less well-tested system model, we felt the Reason software bus gave us the even greater power and flexibility we required to reach our long-term goals.

program component is "standard," i.e., is known to the software bus and occurs across an active bus transmission line. Such transmission lines can be run in series, in parallel, or in any other logical combination. Transmissions from any component can be rerouted to any other component on the bus by a simple command reconfiguring the bus. Such is the flexibility and power of the software bus.

Software-Bus Technical Details

The Reason software bus is a data-transmission protocol between discrete bus-integrated components. Its function is analogous to the functions performed by a hardware bus. In fact, the Reason protocol looks much like a standard packet-switching network protocol, with six transmitted parameters:

- user identification (person or component ID)
- logical transmission-line number (unique data path)
- transmission-origin routing name
- transmission-destination routing name
- transmission verb or command expression (e.g., LOGON, LOGOFF, WRITE, NEXT, etc.)
- transmission data packet

and two returning parameters:

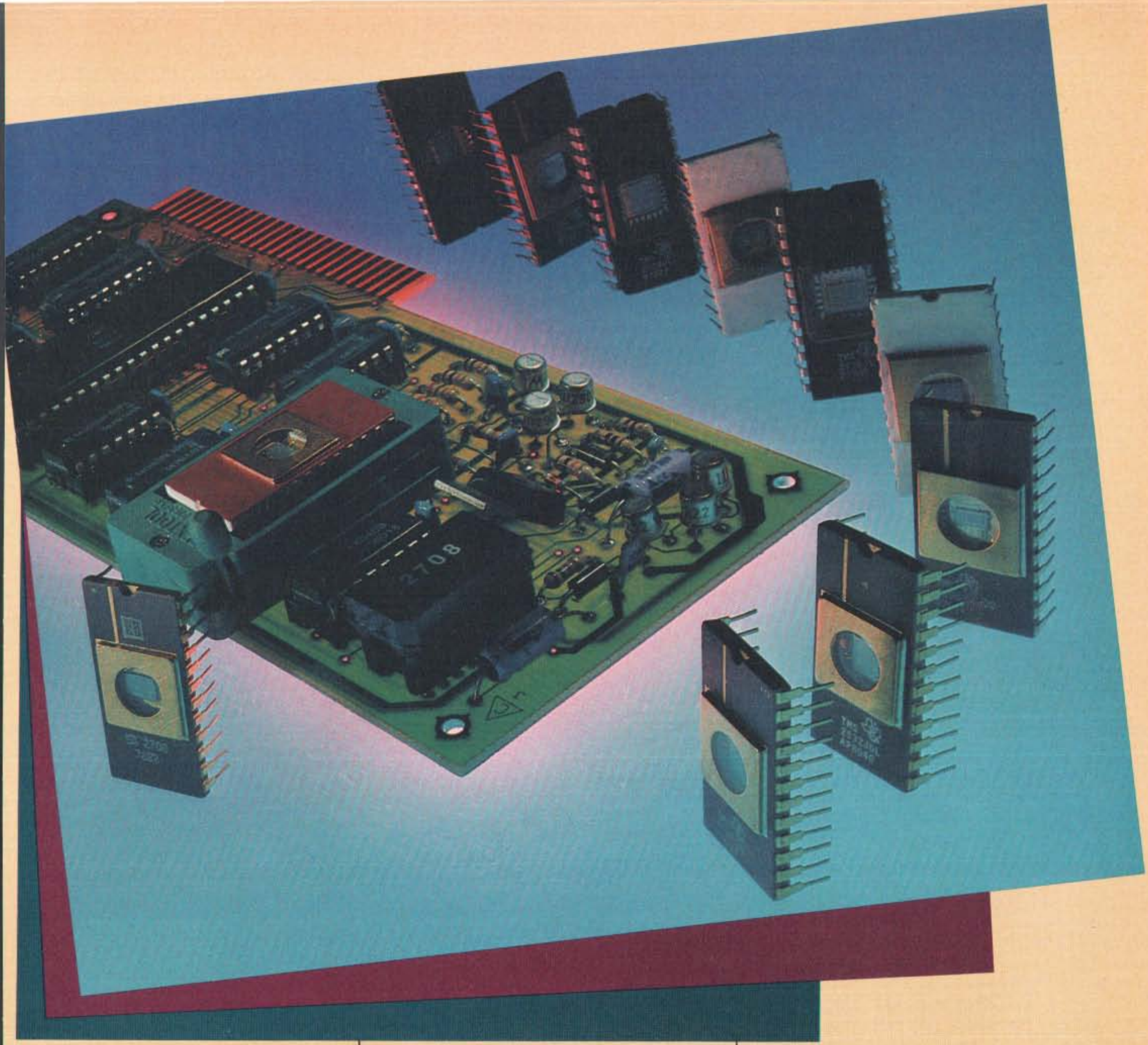
- returned data packet
- transmission status message

The Reason software bus supports each discrete integrated component by providing a code page, a data page, an operations stack, and a data stack. Figure 1 on page 108 demonstrates how these supporting resources interact.

Each time a transmission session on the bus activates a bus-integrated program, a Reason context is created. A newly created timesharing operation is called a task. It is common to have multiple contexts within a single task. It is also possible to have multiple tasks within a single context.

The code page contains the optimized machine-language code that is the bus-integrated program. The Reason protocol allows code pages to vary in size, up to 64K bytes.

Importantly, all Reason bus-integrated components are recursively reentrant. Neither multiple simultaneous contexts nor multitasking applications require multiple copies of the same program code page. Components can invoke themselves or



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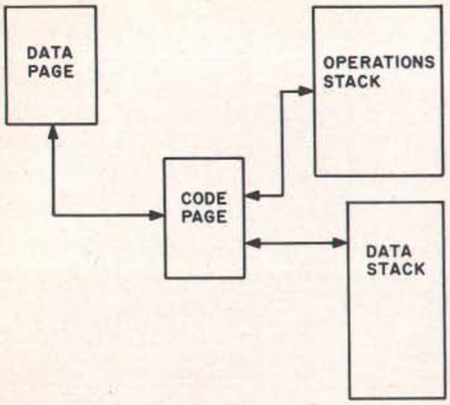

Figure 1: *The interacting resources of the Reason software bus. Each software component on the bus has a code for the program's source code, a data page for variable storage, and operations and data stacks, the "scratchpads" for program operation.*

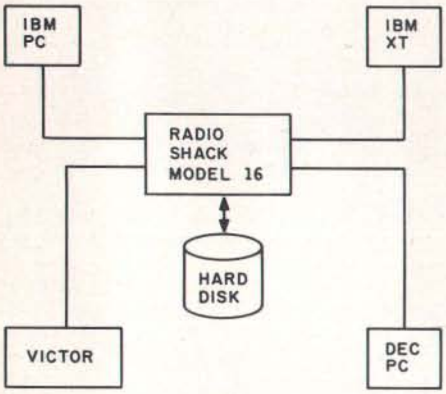

Figure 2: *Each microcomputer runs a version of a Datanet. Datanet masks the differences between each node microprocessor and the network environment. Microcomputers in the network share data as well as execute programs interactively.*

can be invoked many times concurrently and still require only one copy of the object code.

New data pages are supplied for each concurrent invocation, and, as long as the data pages are kept separate, everything operates smoothly. Reason provides a data page for each context. Reason also provides an operations stack and a data stack for each task.

Selecting a Language

Selecting a computing language to implement the Reason software bus was difficult. We needed a high degree of machine independence but could not afford the run-time overhead of previously existing pseudocode languages like Pascal.

Pascal also was too high-level for our purposes, as we needed to work more directly with the machine. We looked at FORTH but decided it was too slow in execution and cumbersome in its linking process. We felt C was fast enough, but it still didn't let us get close enough to the machine.

The N Language

Finally, we chose to develop our own language to support the project. We decided to create a language with two different syntaxes: it would be simultaneously an assembly language and a high-level language. We dubbed this language a "meta-assembler" because of its dual syntax. We called it N, for Network language. (See the accompanying box for details on N, its speed, and its unusual dual syntax.)

The Network Control Program

The Reason software bus is an internally networked data-transmission protocol. In effect, it is a network of independent software components. This network is integrated using a control program somewhat analogous to an operating system. In Reason, this program is appropriately termed a network control program, or simply NCP. By loading a network control program into a machine and creating origin and destination dictionaries, you configure the system.

It is the responsibility of the network control program to support the software bus. How a program is loaded into a code page, how contexts and tasks are started, and how data pages and stacks are allocated are all problems that the NCP must resolve.

Unlike an operating system, however, a network control program is merely another discrete integrated program on the Reason software bus. Network control programs are every bit as interchangeable as any other component in the system. You can construct many different NCPs, simple or complex, to satisfy specific engineering needs. This has interesting implications, especially for networks involving a variety of computers.

In figure 2, all computers might be running copies of the same network control program and sharing the network equally. Or some computers could be running different NCPs, with different functions and orientations. One or more might be running NCPs in a slave mode, and one machine or more might have a master NCP installed, determining the specific tasks of the other computers.

The problems of networking personal computers—from the same manufacturer, let alone of different brands—have been hard to solve at the software level using other technologies. Once the Reason software bus has been installed on a number of machines, however, these problems shrink to the less difficult activity of configuring network control programs for different tasks and relationships among the networked computers.

Building the First NCP

Datanet, the first network control program written for the Reason project, is designed as a multicontext, single-tasking, microcomputer network control program. It is a discrete, integrated component on the Reason software bus. This first NCP manages up to 1 megabyte of RAM (random-access read/write memory) and up to 12 concurrent program contexts and uses as little as 300K bytes of floppy-disk storage or as much as 15 megabytes of hard-disk storage.

Copies of Datanet operating concurrently on different microcomputers can be used to create a network machine. Each computer in the network shares program contexts and exchanges data. Network machines can duplicate tasks for redundancy, or a large problem can be broken up into smaller activities to take advantage of the parallelism of the network.

The design of Datanet allows maximum flexibility. As figure 3 illustrates, the Datanet kernel is nothing more than a network transmission

Text continued on page 112

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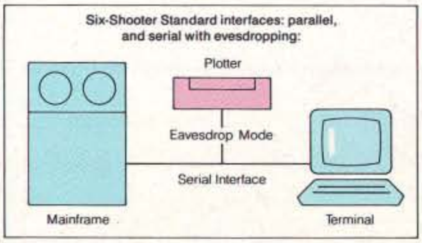

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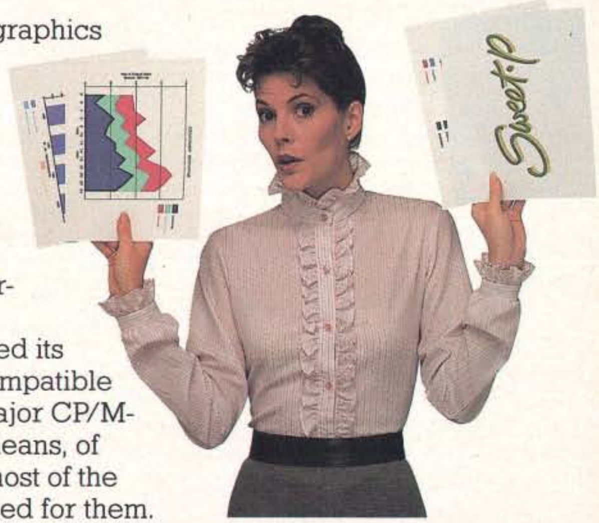

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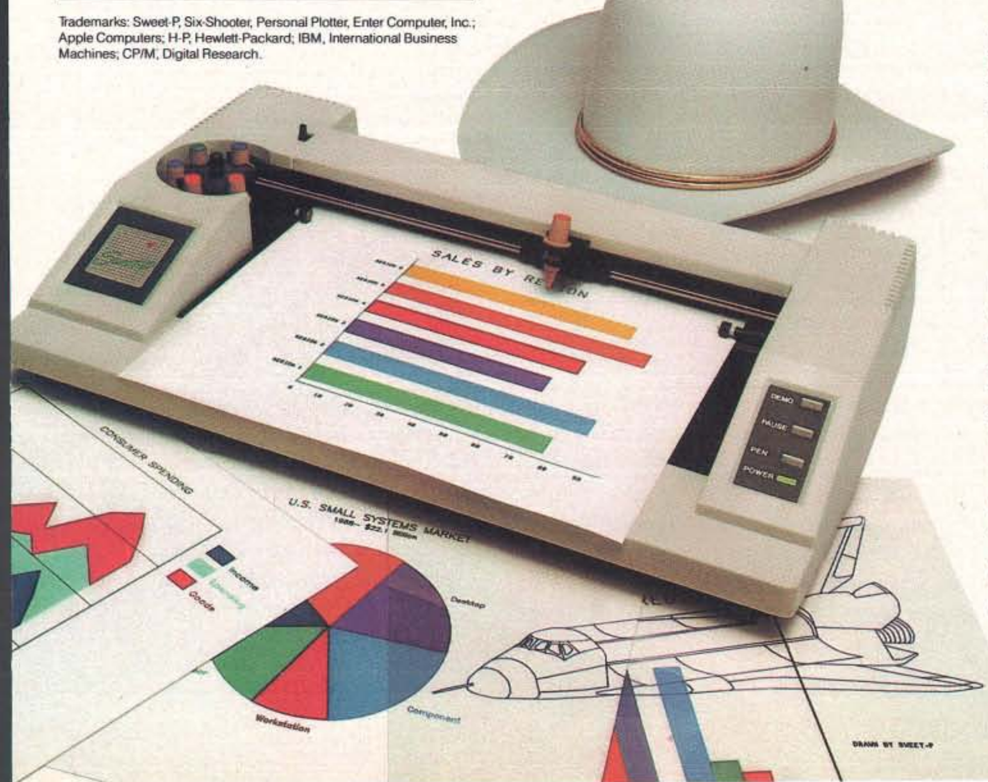

The Reason Network Language

The N language is an assembler for a very well defined, imaginary, stack-oriented, pseudocode-like machine. Programs can be written, one p-code per line, exactly as with assemblers for real machines. But high-level syntax can also be used, which is why we call it a "meta-assembler."

Unlike many other p-code machines, the N p-codes never appear in the target machine. The N compiler outputs what in Reason is called a Compiler Normal Form file. This file is then passed through O, the Reason binary code generating optimizer. And, the final form of an N language program is optimized binary machine language for the target machine.

The result is that N language programs are highly portable yet very fast. Currently the N language operates on the Motorola 68000 and the Intel 8086 family of processors. Reason also plans to create optimizer tables for the National Semiconductor 16032 and other microprocessors.

N language programs can be written in normal assembly-language format or in high-level syntax. Listings 1 and 2 demonstrate N's unusual feature of a dual syntactical structure.

Significantly, both forms of the program are equivalent. O will output the identical optimized binary machine code regardless of the form used.

O, another product of the first generation of Reason, is a 900 template optimizer with expression reduction and register allocation. Since the optimizer is table driven, only one copy of the optimizer is required for all target machines. Changing the optimizer's tables generates machine code for a new target machine.

A study published in the Gilbreath article cited in the main text displayed times for execution of a prime-number generating program written in several different compilers on the Motorola 68000. A comparison of results (table 1) for the same prime-number generator written in N yields some indication of the efficiency of N and O on the 68000 relative to the nine top performers in the Gilbreaths' study.

Listing 1: *The assembler-like syntax variation of the proprietary language, N.*

```
START:      #LCD{K}           /* LOAD ADDRESS OF INTEGER VARIABLE*/
            #LOD{I}           /* LOAD INTEGER ONTO STACK          */
            #LCI{0}           /* LOAD INTEGER CONSTANT ONTO
                              STACK                               */
            #CPI{GE}          /* IS K GREATER THAN OR EQUAL TO 0 ? */
            #JCF{ELSE}        /* JUMP IF K LESS THAN 0            */
THEN:       #LCI{1}           /* LOAD INTEGER CONSTANT ONTO
                              STACK                               */
            #LCD{N}           /* LOAD ADDRESS OF INTEGER VARIABLE*/
            #SVD{I}           /* SAVE INTO INTEGER VARIABLE       */
            #JMP(CONTINUE)    /* JUMP AROUND ELSE                 */
ELSE:       #LCI{-1}          /* LOAD INTEGER CONSTANT ONTO
                              STACK                               */
            #LCD{N}           /* LOAD ADDRESS OF INTEGER VARIABLE*/
            #SVD{I}           /* SAVE INTO INTEGER VARIABLE       */
CONTINUE:
```

Listing 2: *The high-level syntax of N.*

```
START:    IF [K>=0] THEN [N:=1] ELSE [N:=-1]
CONTINUE:
```

Computer	Language	Time (seconds)
68000 8 MHz	Assembly	0.49
68000 8 MHz	SMPL (Ebnek)	2.6
68000 8 MHz	N	2.85
68000 8 MHz (Sun PM68K)	Pascal (Telesoft)	4.28
68000 8 MHz (Sun PM68K)	Ada (Telesoft)	4.4
68000 Wicat 150WS	C (Johnson)	4.71
68000 8 MHz (HP-9830)	Ada (Telesoft)	4.0
68000 8 MHz (HP-9830)	Pascal (Telesoft)	5.0
68000 8 MHz	Pascal (Softech Nat.)	5.0
68000 8 MHz	Pascal (IMS Inc.)	5.8
68000 8 MHz (HP-9830)	Pascal (Hewlett-Packard)	5.9

Table 1: *Results of a prime-number generating program in a variety of languages running on 68000 processors.*

Reason optimization tools will also include a table-driven, assembly-language source generating optimizer to be called S. This optimizer will generate native assembly language files in one-to-one correspondence with the binary output of the code generating optimizer. S would be used in the event that an O-optimized N program were not fast enough for some special implementation. In such a case, compiler normal form would be passed through S to produce native assembly-language source. An engineering technician would then further optimize this source by hand, until it was as close to assembly-language speeds as the implementation required.

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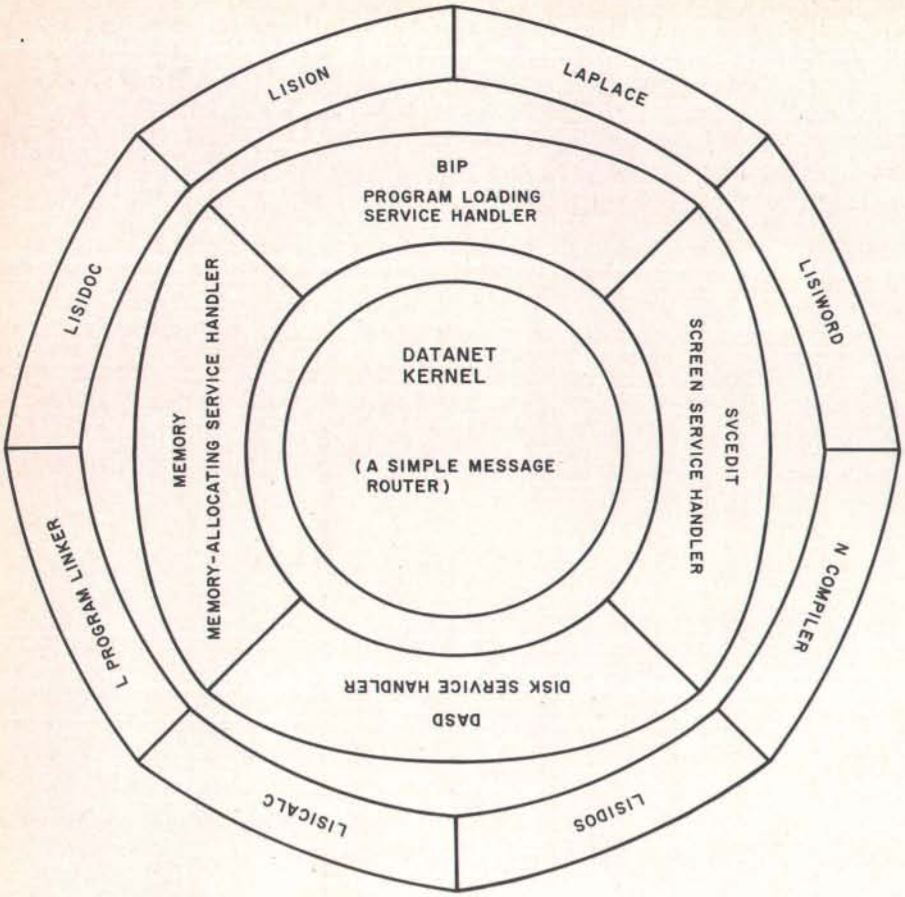

Figure 3: *The Datanet system is constructed from a layered collection of discrete components with a single message router at the center. There are no operating systems or applications programs, just a collection of components, each sending messages to all the other components.*

Text continued from page 108:

manager. All of the actual work is performed by the Datanet system service handlers (SSHs), independent modules through which Datanet routes all transmissions.

Datanet comes with several resident system service handlers, and additional disk-resident SSHs are available as well. Datanet's use of disk-resident SSHs allows an engineer wide flexibility in dynamically extending or constricting Datanet for specific environments.

The Laplace Interpreter

With an NCP and other bus-integrated programs available, it remained to complete the actual software bus by linking these components.

To picture this problem, consider how a printed-circuit board joins unrelated components in a hardware bus design to create products. How are two popular 16-bit computers—the DEC Rainbow and the IBM PC—related? From our human point of view, the difference between these two computers is clear. They look different, they have different keyboards, and they come from different manufacturers.

Yet, from an engineering standpoint, they and other computers share many of the same integrated circuits and components. Under their covers may lie the same microprocessor, memory chips, and logic circuitry. Seen from the point of view of an integrated-circuit manufacturer, each of these computers might be thought of as merely a different *user view* of mostly identical components.

How could we on the Reason research project construct software user views? Obviously, in software we could not use a physical surface such as a printed-circuit board. Instead, we would need an algorithmic language to logically connect our various software-bus components. To speed up development of the Reason project's user views (the applications software), we decided that this language would be interpreted.

Existing Choices

Once again, we undertook a review of the existing technology in the area of interpreters. We looked first, of course, at BASIC. The syntax style of BASIC is easy to learn and use, which means that programming neophytes might be able to develop user views on the Reason software bus.

Because BASIC programs are readable after any number of revisions, maintenance is fairly easy. But BASIC lacks the modularity necessary for large engineering projects. We had to reject it as the language of choice.

APL has simple and efficient modularity, but its syntax is too esoteric and difficult to maintain. FORTH, the only other interpreter we considered at length, is extensible: user-defined commands can extend the language's vocabulary with new words—a very desirable feature. Another FORTH advantage is its ability to get at the machine.

But FORTH did not fulfill our syntactical requirements for readability. So, as you might expect, once again, we decided to create our own interpreter, combining all these desirable features. We call it Laplace.

Laplace is an interpretive language in the same syntax family as BASIC. It has the modularity and recursion of APL. It also has the extensibility and machine facilities of FORTH. The Laplace interpreter is one more bus-integrated component, a discrete software module running on the Reason software bus.

A Laplace Listing

Listing 1 is a prime-number program coded as a user-defined command in Laplace. Versions of this program in many different languages appeared in an article by Jim Gilbreath and Gary Gilbreath (see "Eratosthenes Revisited: Once More through the Sieve," January 1983 BYTE, page 283). Listing 1 allows comparison of Laplace syntax with that of other languages.

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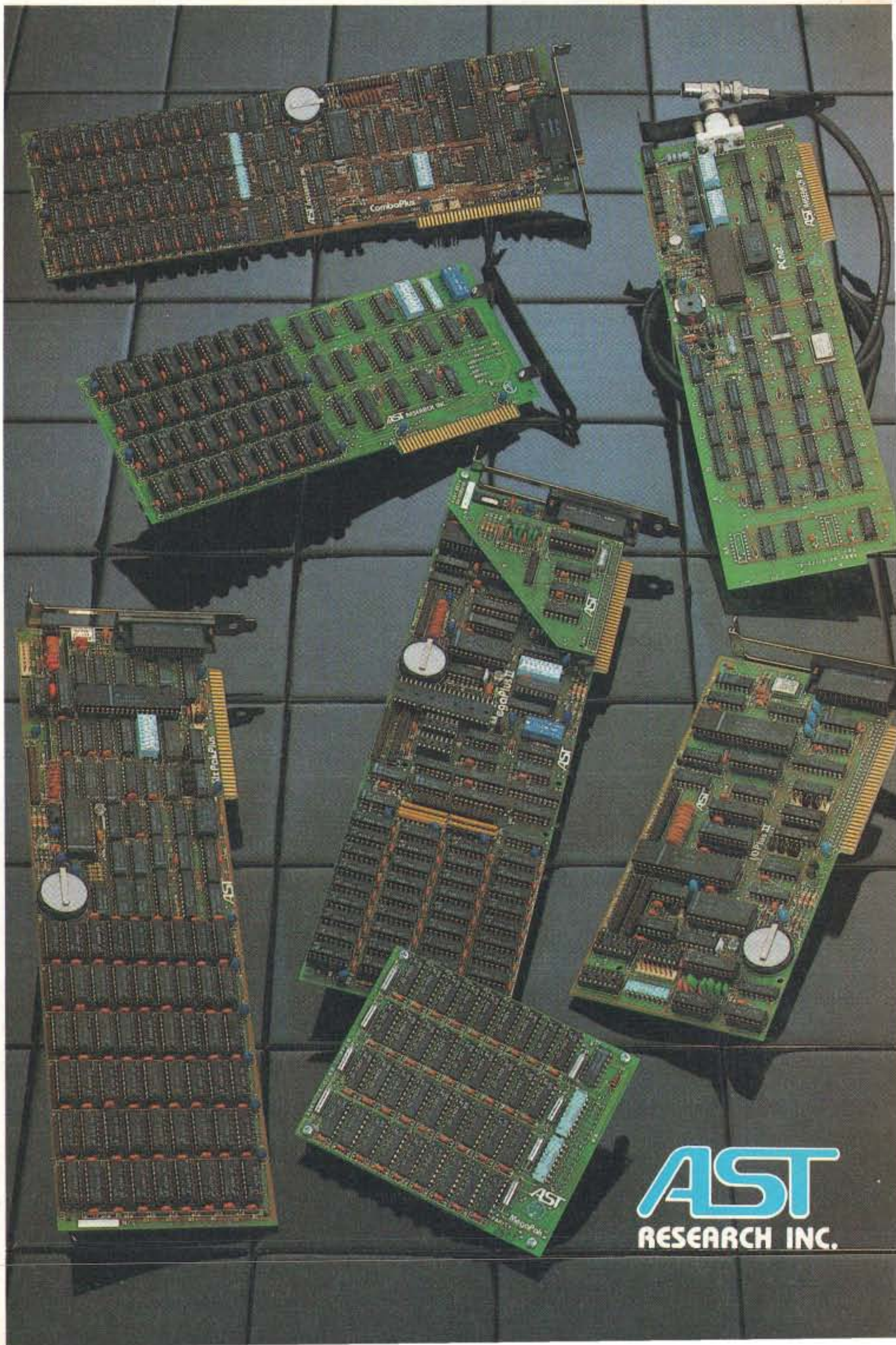


Listing 1: *A prime-number generator written for the Laplace interpreter.*

```
100  DEF, PRIME
110  DIM,flags[8191]{i},m{i},count{i},prime{i},k{i},i{i}
120  ?"10 iterations"
130  FOR{M=1,10}:count=0
140  FOR{i=0,8190}:flags[i]=1:NEXT!
150  FOR{i=0,8190}
160  IF{flags[i]=0}THEN:GOTO,210
170  prime=i+i+3:?prime:k=i+prime
180  IF{k>8190}THEN:GOTO,200
190  flags[k]=0:k=k+prime:GOTO,180
200  count=count+1
210  NEXT!
220  NEXT!
230  ?count," primes"
240  END!
```

Our First User View

With Laplace in our software toolbox, it was now time for the acid test. Could the Reason research project accomplish anything with these shiny new software tools? It was time to construct the first user view.

To preserve the bus metaphor and perform this task efficiently, this user view would have to be a selection of discrete bus-integrated components fitted together via interpretive Laplace programs and merged into a system configuration. Of course, with this as with all user views, the computer user would not need to see inside the creation.

From the user's point of view, this new creation seems just like any other large, complex application program, in the same way that a DEC Rainbow and an IBM PC appear to a user as distinct computers, rather than two different user views of mostly the same components.

We chose to develop an advanced user view—a complete software environment comparable to Visicorp's Visi On and the software running on Apple's Lisa.

Could we develop, without high-resolution hardware or a mouse, a user view of such sophistication? We decided to try and to refer to this environment as Lision.

Lision

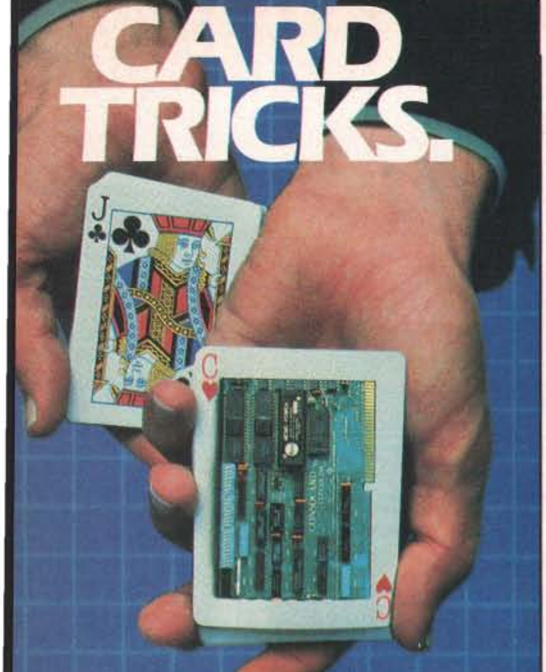
In order to fully test the productivity of the new software tools, we assigned one senior software engineer full-time to the project. Single-handedly, this engineer would have to connect existing bus components together with Laplace algorithms to form

- a multiple-screen context (window) applications interface
- a disk operating system, similar in its functions to MS-DOS, which would operate out of any of the screen contexts
- an advanced spreadsheet program
- a full-service text editor
- a document printer/formatter for combining text files into large printed documents
- a database-management system

The result, Lision, operates efficiently in 320K bytes of RAM, using as little as 300K bytes of disk space. (See photos 1 through 11.)

The document printer/formatter can produce documents of up to 500 pages and automatically generates a table of contents, headers, etc. The disk operating system can perform directories, memory dumps, interactive debugging, generic file copies, deletes, merges, and even generic N compiles or native assemblies.

The Lision text editor does line or column move or copy, group search or replace, wrap-around paragraph managing, and even sorting. The spreadsheet is fully programmable. It includes all the transcendental functions, IF. . .THEN statements, user definable commands, and a wide range of full programming features.



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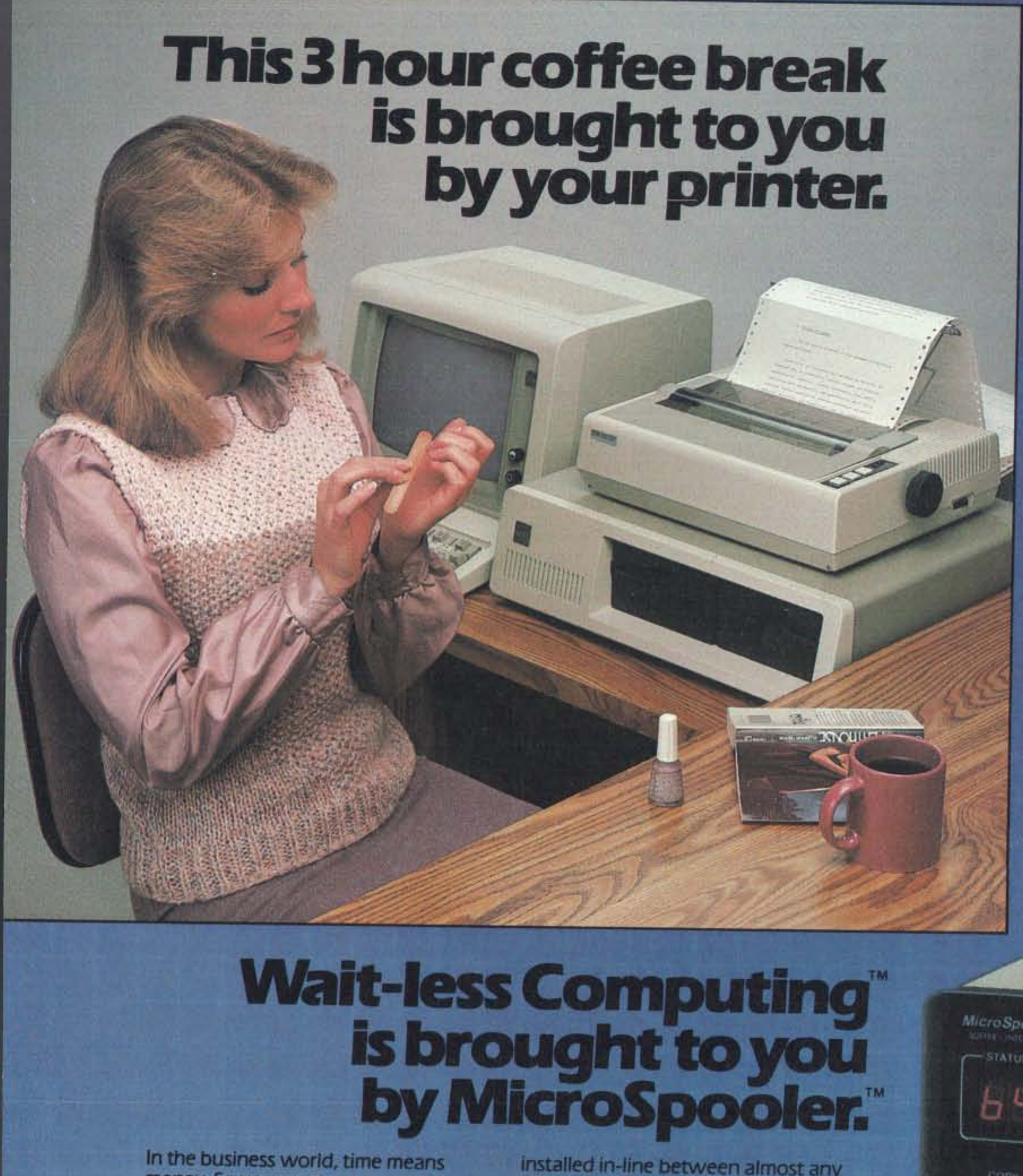

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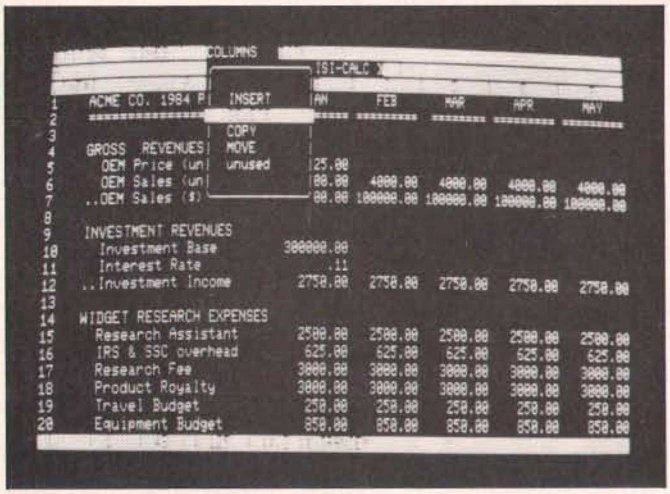
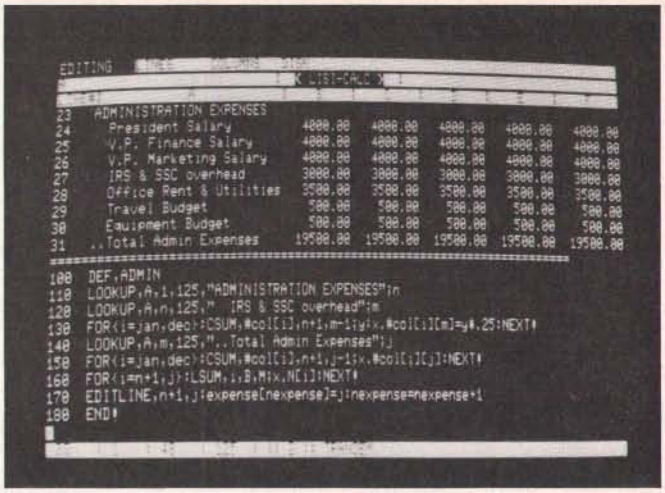


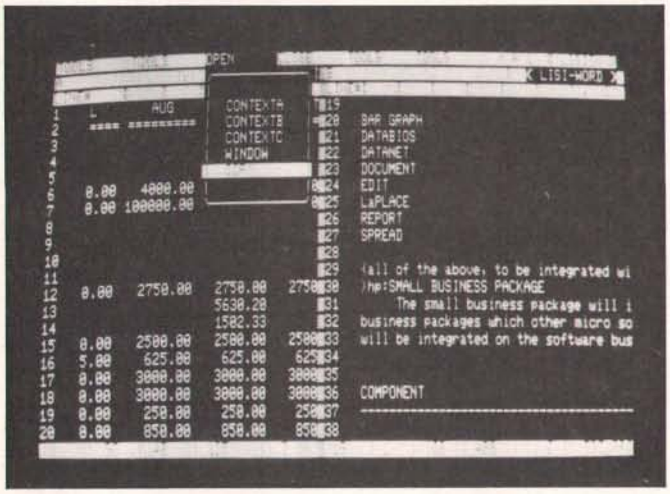
```
                    COLUMNS
                              ISI-CALC
 1   ACME CO. 1984 P| INSERT  |AN      FEB       MAR       APR       MAY
 2   ===============          ===== ========= ======== ========= =========
 3                  | COPY
 4   GROSS  REVENUES| MOVE
 5     OEM Price (un| unused  |25.00
 6     OEM Sales (un|         |00.00   4000.00   4000.00   4000.00   4000.00
 7   ..OEM Sales ($)          -00.00 100000.00 100000.00 100000.00 100000.00
 8
 9   INVESTMENT REVENUES
10     Investment Base      300000.00
11     Interest Rate              .11
12   ..Investment Income      2750.00   2750.00   2750.00   2750.00   2750.00
13
14   WIDGET RESEARCH EXPENSES
15     Research Assistant     2500.00   2500.00   2500.00   2500.00   2500.00
16     IRS & SSC overhead      625.00    625.00    625.00    625.00    625.00
17     Research Fee           3000.00   3000.00   3000.00   3000.00   3000.00
18     Product Royalty        3000.00   3000.00   3000.00   3000.00   3000.00
19     Travel Budget           250.00    250.00    250.00    250.00    250.00
20     Equipment Budget        850.00    850.00    850.00    850.00    850.00
```

Photo 1: *Lisicalc, the Transoft spreadsheet, shown with one of its pop-up menus.*



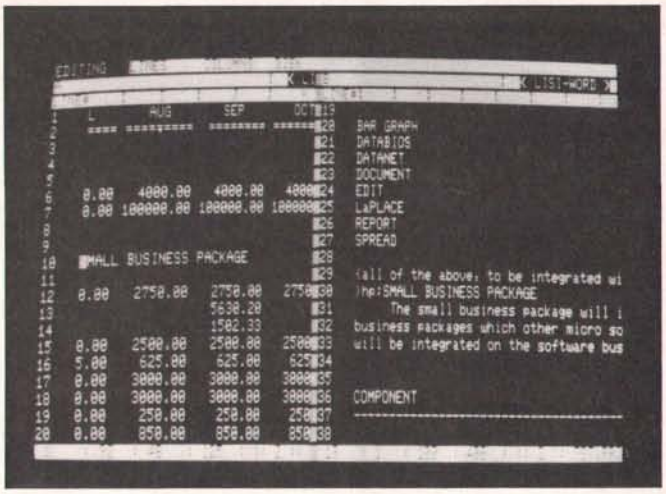
```
EDITING
                          < LISI-CALC >
23   ADMINISTRATION EXPENSES
24     President Salary          4000.00   4000.00   4000.00   4000.00   4000.00
25     V.P. Finance Salary       4000.00   4000.00   4000.00   4000.00   4000.00
26     V.P. Marketing Salary     4000.00   4000.00   4000.00   4000.00   4000.00
27     IRS & SSC overhead        3000.00   3000.00   3000.00   3000.00   3000.00
28     Office Rent & Utilities   3500.00   3500.00   3500.00   3500.00   3500.00
29     Travel Budget              500.00    500.00    500.00    500.00    500.00
30     Equipment Budget           500.00    500.00    500.00    500.00    500.00
31   ..Total Admin Expenses     19500.00  19500.00  19500.00  19500.00  19500.00
===============================================================================
100  DEF,ADMIN
110  LOOKUP,A,1,125,"ADMINISTRATION EXPENSES";n
120  LOOKUP,A,n,125,"  IRS & SSC overhead";m
130  FOR(i=jan,dec):CSUM,#col[i],n+1,m-1;y;x,#col[i][m]=y*.25:NEXT!
140  LOOKUP,A,m,125,"..Total Admin Expenses";j
150  FOR(i=jan,dec):CSUM,#col[i],n+1,j-1;x,#col[i][j]:NEXT!
160  FOR(i=n+1,j):LSUM,i,B,M;x,N[i]:NEXT!
170  EDITLINE,n+1,j:expense[nexpense]=j:nexpense=nexpense+1
180  END!
```

Photo 2: *The spreadsheet shown with the program it automatically generates. Programs in the Laplace interpreter can generate spreadsheets, and use of the spreadsheet generates programs.*



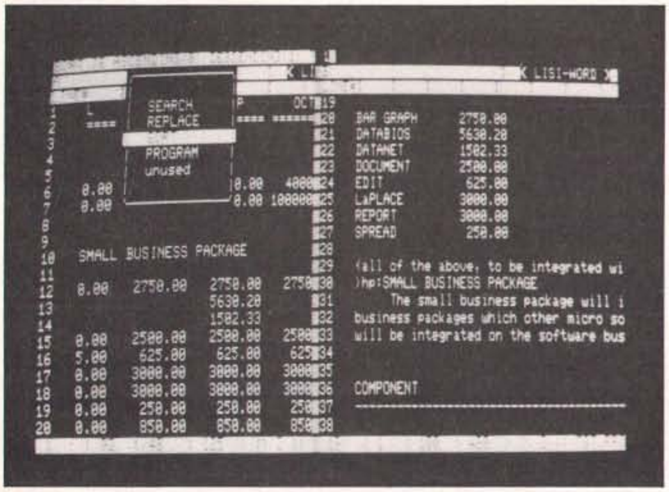
```
                     OPEN
                                                    < LISI-WORD >
 1    L      AUG    CONTEXTA    T 19
 2  ==== =========  CONTEXTB    = 20   BAR GRAPH
 3                  CONTEXTC      21   DATABIOS
 4                  WINDOW        22   DATANET
 5                                23   DOCUMENT
 6  0.00   4000.00              0 24   EDIT
 7  0.00 100000.00              0 25   LaPLACE
 8                                26   REPORT
 9                                27   SPREAD
10                                28
11                                29   (all of the above, to be integrated wi
12  0.00   2750.00   2750.00  2750 30   )hp:SMALL BUSINESS PACKAGE
13                   5630.20      31        The small business package will i
14                   1582.33      32   business packages which other micro so
15  0.00   2500.00   2500.00  2500 33   will be integrated on the software bus
16  5.00    625.00    625.00   625 34
17  0.00   3000.00   3000.00  3000 35
18  0.00   3000.00   3000.00  3000 36   COMPONENT
19  0.00    250.00    250.00   250 37   -------------------------------------
20  0.00    850.00    850.00   850 38
```

Photo 5: *The spreadsheet and word processor in different windows. The user is preparing to copy the title "SMALL BUSINESS PACKAGE" from the text file at right directly into the spreadsheet at left. Large blocks of text can also be moved.*



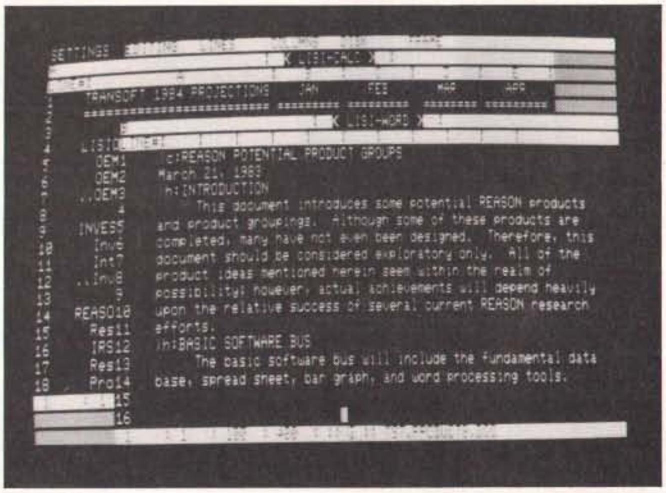
```
EDITING
                             < LI                   < LISI-WORD >
 1    L      AUG       SEP      OCT 19
 2  ==== ========= ======== ====== 20   BAR GRAPH
 3                                 21   DATABIOS
 4                                 22   DATANET
 5                                 23   DOCUMENT
 6  0.00   4000.00   4000.00   4000 24   EDIT
 7  0.00 100000.00 100000.00 100000 25   LaPLACE
 8                                 26   REPORT
 9                                 27   SPREAD
10   MALL BUSINESS PACKAGE         28
11                                 29   (all of the above, to be integrated wi
12  0.00   2750.00   2750.00   2750 30   )hp:SMALL BUSINESS PACKAGE
13                   5630.20       31        The small business package will i
14                   1582.33       32   business packages which other micro so
15  0.00   2500.00   2500.00   2500 33   will be integrated on the software bus
16  5.00    625.00    625.00    625 34
17  0.00   3000.00   3000.00   3000 35
18  0.00   3000.00   3000.00   3000 36   COMPONENT
19  0.00    250.00    250.00    250 37   -------------------------------------
20  0.00    850.00    850.00    850 38
```

Photo 6: *The heading now appears in the spreadsheet.*



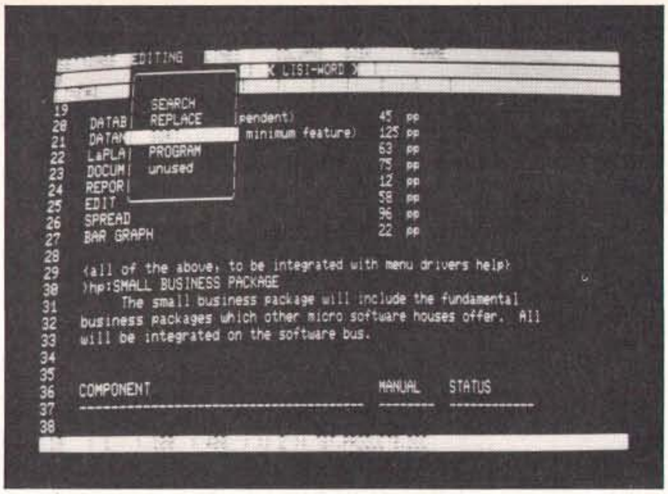
```
                        < LI                       < LISI-WORD >
 1    L    SEARCH   P        OCT 19
 2  ====   REPLACE  ==== ====== 20   BAR GRAPH       2750.00
 3                              21   DATABIOS        5630.20
 4         PROGRAM              22   DATANET         1582.33
 5         unused               23   DOCUMENT        2500.00
 6  0.00            0.00   4000 24   EDIT             625.00
 7  0.00            0.00 100000 25   LaPLACE         3000.00
 8                              26   REPORT          3000.00
 9                              27   SPREAD           250.00
10  SMALL BUSINESS PACKAGE      28
11                              29   (all of the above, to be integrated wi
12  0.00   2750.00   2750.00  2750 30   )hp:SMALL BUSINESS PACKAGE
13                   5630.20      31        The small business package will i
14                   1582.33      32   business packages which other micro so
15  0.00   2500.00   2500.00  2500 33   will be integrated on the software bus
16  5.00    625.00    625.00   625 34
17  0.00   3000.00   3000.00  3000 35
18  0.00   3000.00   3000.00  3000 36   COMPONENT
19  0.00    250.00    250.00   250 37   -------------------------------------
20  0.00    850.00    850.00   850 38
```

Photo 9: *Preparing to do a descending alphabetic sort on a column of words.*



```
SETTINGS
                          < LISICALC >
    TRANSOFT 1984 PROJECTIONS     JAN       FEB       MAR       APR
    ========================= ========= =========  ======== =========
                               < LISI-WORD >
 4  LISIC
 5     OEM1   c:REASON POTENTIAL PRODUCT GROUPS
 6     OEM2   March 21, 1983
 7   ..OEM3   h:INTRODUCTION
 8        4        This document introduces some potential REASON products
 9   INVES5   and product groupings.  Although some of these products are
10     Inv6   completed, many have not even been designed.  Therefore, this
11     Int7   document should be considered exploratory only.  All of the
12   ..Inv8   product ideas mentioned herein seem within the realm of
13        9   possibility; however, actual achievements will depend heavily
14  REASO10   upon the relative success of several current REASON research
15    Res11   efforts.
16    IRS12   h:BASIC SOFTWARE BUS
17    Res13        The basic software bus will include the fundamental data
18    Pro14   base, spread sheet, bar graph, and word processing tools.
          15
          16
```

Photo 10: *A Lisiword window overlapping a Lisicalc window.*



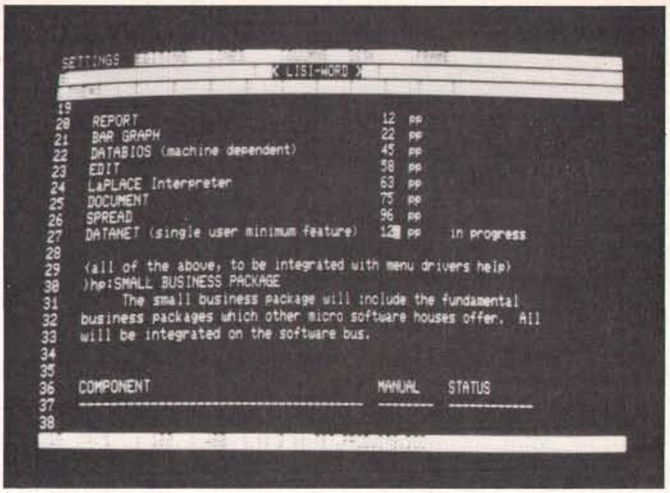
```
EDITING
                        < LISI-WORD >

          SEARCH
 DATAB|   REPLACE     |pendent)              45  pp
 DATAN|                minimum feature)     125  pp
 LaPLA|   PROGRAM     |                      63  pp
 DOCUM|   unused      |                      75  pp
 REPOR|               |                      12  pp
 EDIT  ----------------                      58  pp
 SPREAD                                      96  pp
 BAR GRAPH                                   22  pp

(all of the above, to be integrated with menu drivers help)
)hp:SMALL BUSINESS PACKAGE
     The small business package will include the fundamental
business packages which other micro software houses offer.  All
will be integrated on the software bus.


COMPONENT                                 MANUAL   STATUS
----------------------------------------- -------- ------------
```

Photo 3: *Lisiword, the word processor, preparing to sort a list of numbers in a text file.*



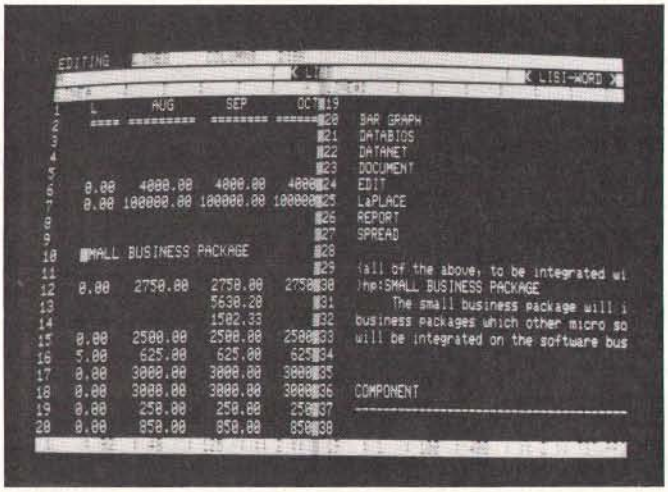
```
SETTINGS
                        < LISI-WORD >

 REPORT                                      12  pp
 BAR GRAPH                                   22  pp
 DATABIOS (machine dependent)                45  pp
 EDIT                                        58  pp
 LaPLACE Interpreter                         63  pp
 DOCUMENT                                    75  pp
 SPREAD                                      96  pp
 DATANET (single user minimum feature)      12█ pp    in progress

(all of the above, to be integrated with menu drivers help)
)hp:SMALL BUSINESS PACKAGE
     The small business package will include the fundamental
business packages which other micro software houses offer.  All
will be integrated on the software bus.

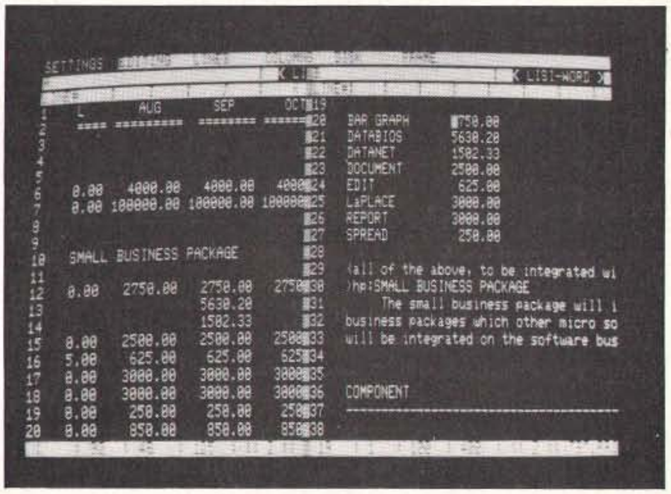

COMPONENT                                 MANUAL   STATUS
----------------------------------------- -------- ------------
```

Photo 4: *The page numbers in the text file are now in ascending order.*



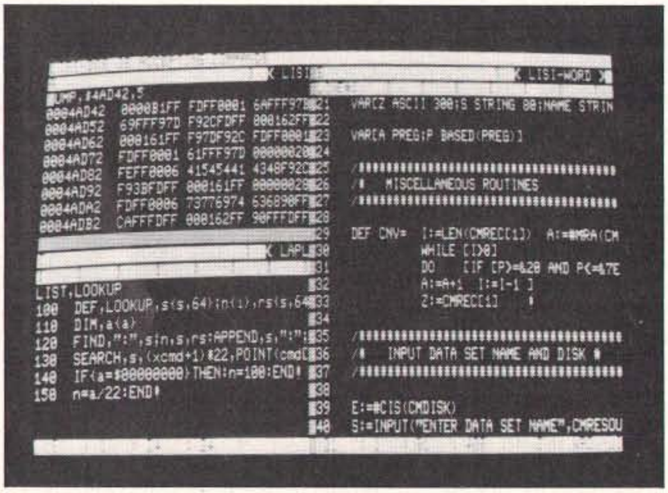
```
EDITING
                          < LI                        < LISI-WORD >
1     L       AUG        SEP       OCT
2   ==== =========  ======== ======      BAR GRAPH
3                                        DATABIOS
4                                        DATANET
5                                        DOCUMENT
6   0.00   4000.00   4000.00   4000      EDIT
7   0.00 100000.00 100000.00 100000      LaPLACE
8                                        REPORT
9                                        SPREAD
10  █MALL BUSINESS PACKAGE
11                                       (all of the above, to be integrated wi
12  0.00   2750.00   2750.00   2750      )hp:SMALL BUSINESS PACKAGE
13                   5630.20                  The small business package will i
14                   1502.33             business packages which other micro so
15  0.00   2500.00   2500.00   2500      will be integrated on the software bus
16  5.00    625.00    625.00    625
17  0.00   3000.00   3000.00   3000
18  0.00   3000.00   3000.00   3000      COMPONENT
19  0.00    250.00    250.00    250      ----------------------------------------
20  0.00    850.00    850.00    850
```

Photo 7: *Preparing to copy a column of numbers from the spreadsheet into the text file.*



```
SETTINGS
                          < LI                        < LISI-WORD >
1     L       AUG        SEP       OCT
2   ==== =========  ======== ======      BAR GRAPH       █750.00
3                                        DATABIOS        5630.20
4                                        DATANET         1502.33
5                                        DOCUMENT        2500.00
6   0.00   4000.00   4000.00   4000      EDIT             625.00
7   0.00 100000.00 100000.00 100000      LaPLACE         3000.00
8                                        REPORT          3000.00
9                                        SPREAD           250.00
10  SMALL BUSINESS PACKAGE
11                                       (all of the above, to be integrated wi
12  0.00   2750.00   2750.00   2750      )hp:SMALL BUSINESS PACKAGE
13                   5630.20                  The small business package will i
14                   1502.33             business packages which other micro so
15  0.00   2500.00   2500.00   2500      will be integrated on the software bus
16  5.00    625.00    625.00    625
17  0.00   3000.00   3000.00   3000
18  0.00   3000.00   3000.00   3000      COMPONENT
19  0.00    250.00    250.00    250      ----------------------------------------
20  0.00    850.00    850.00    850
```

Photo 8: *The numbers now appear in the Lisiword text file.*



```
                          < LISI                      < LISI-WORD >
█UMP,$4AD42,5
0004AD42  000081FF FDFF0001 6AFFF97D     VARIZ ASCII 300;S STRING 80;NAME STRIN
0004AD52  69FFF97D F92CFDFF 000162FF
0004AD62  000161FF F97DF92C FDFF0001     VARIA PREG;P BASED(PREG)]
0004AD72  FDFF0001 61FFF97D 00000020
0004AD82  FEFF0006 41545441 4348F92C     /#####################################
0004AD92  F93BFDFF 000161FF 00000020     /#   MISCELLANEOUS ROUTINES
0004ADA2  FDFF0006 73776974 636890FF     /#####################################
0004ADB2  CAFFFDFF 000162FF 90FFFDFF
                                         DEF CNV=  I:=LEN(CMREC[1])  A:=#MRA(CM
                          < LAPL                   WHILE [I>0]
                                                   DO    [IF [P]>=&20 AND P<=&7E
                                                   A:=A+1  I:=I-1 ]
LIST,LOOKUP                                        Z:=CMREC[1]     #
100  DEF,LOOKUP,s(s,64)in(i),rs(s,64
110  DIM,a(a)
120  FIND,":",s;n,s,rs:APPEND,s,":";     /#####################################
130  SEARCH,s,(xcmd+1)*22,POINT(cmd[     /#   INPUT DATA SET NAME AND DISK #
140  IF(a=$00000000)THEN:n=100:END!      /#####################################
150  n=a/22:END!

                                         E:=#CIS(CMDISK)
                                         S:=INPUT("ENTER DATA SET NAME",CMRESOU
```

Photo 11: *Three Lision windows showing a dump for a machine language file in hexadecimal, a program written in the Laplace interpreter, and a program written in the N compiler.*

Lision's database-management system is not quite finished at this writing. When complete, it will include masked screen display, data entry, and creation; automatic report generation and creation of report formats; and impromptu inquiry in an English-like query language.

Lision features a single-line menu at the top of the display for highlighting current user options. Function keys take the place of the mouse for selecting menu options and do not disturb the normal cursor position in the current window. Furthermore, the system features user-programmable function keys (softkeys) to automate menu selections or any other operations.

Lision allows multiple programs to operate simultaneously, each with its own different screen. Windows can be placed anywhere on the display and may be of any size. They may overlap, be side to side, on top of one another, and so on (the desktop metaphor). Data can be transferred from any window into any other.

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Using the new software bus tools, the Reason research project created Lision in less than 10 person-weeks. Lision was begun on July 15, 1983, and the first draft of this article was written on September 27, 1983, using Lision.

Summary

Design work on the Reason software bus began on July 1, 1981. Final cleanup on this generation of tools should be completed before you read this article. The bus and Lision are currently operational, although they require beta testing and bug fixes.

The entire Reason software bus was developed in less than 36 engineering person-months. Equipment used in the project comprised two 68000-based desktop computers and an IBM PC system modified by inclusion of a 68000 board manufactured by Analytical Engines Inc. of Austin, Texas.

One favorable compiler timing comparison and one favorable applications development project do not a technology make. Of course, we at the Reason research project are excited about our progress. We have high hopes for the future. However, if software-busing concepts, and the Reason software bus in particular, are to become a factor in future technology, they must remain productive across a number of tests and within a number of different environments.

If they continue to be productive, it's possible that software-busing concepts may form a new software technology with dramatic effects on the software choices of the future.

Because of this possibility, members of the Reason research project, together with other associates, have formed a company called Transoft Corporation to market the products of Reason research. Lision, no doubt under another name, will be one of the company's first products.■

Michael F. Korns has been a software engineer for 18 years. He has worked in systems design for IBM, as a DP Manager for Tymshare, and until 1981 was a principal in Computhink (now called Momentum Inc.). A student of mathematics, his primary interest is in artificial-intelligence software. He can be reached at Transoft Corporation, 233 Page St., San Francisco, CA 94117.

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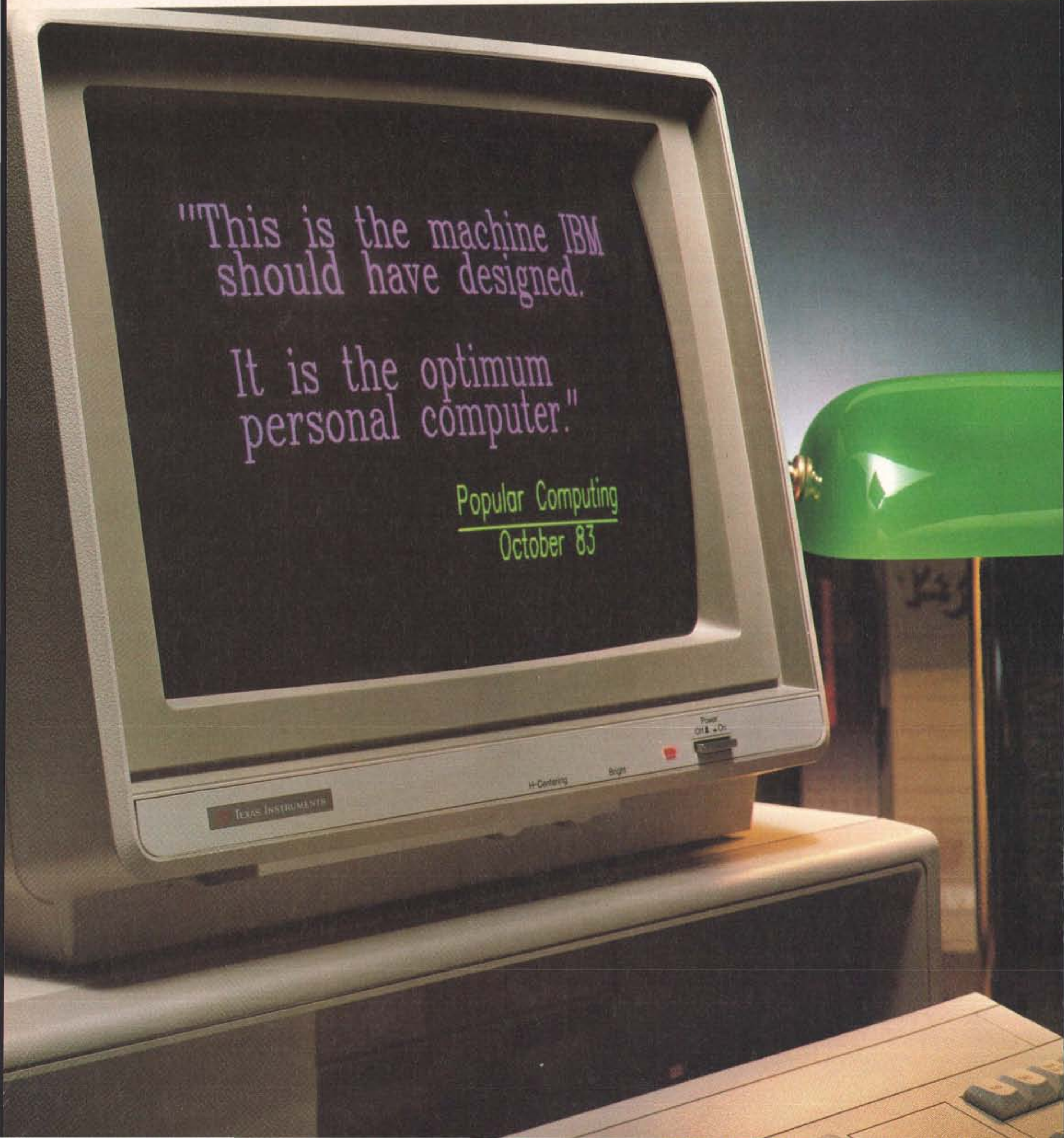
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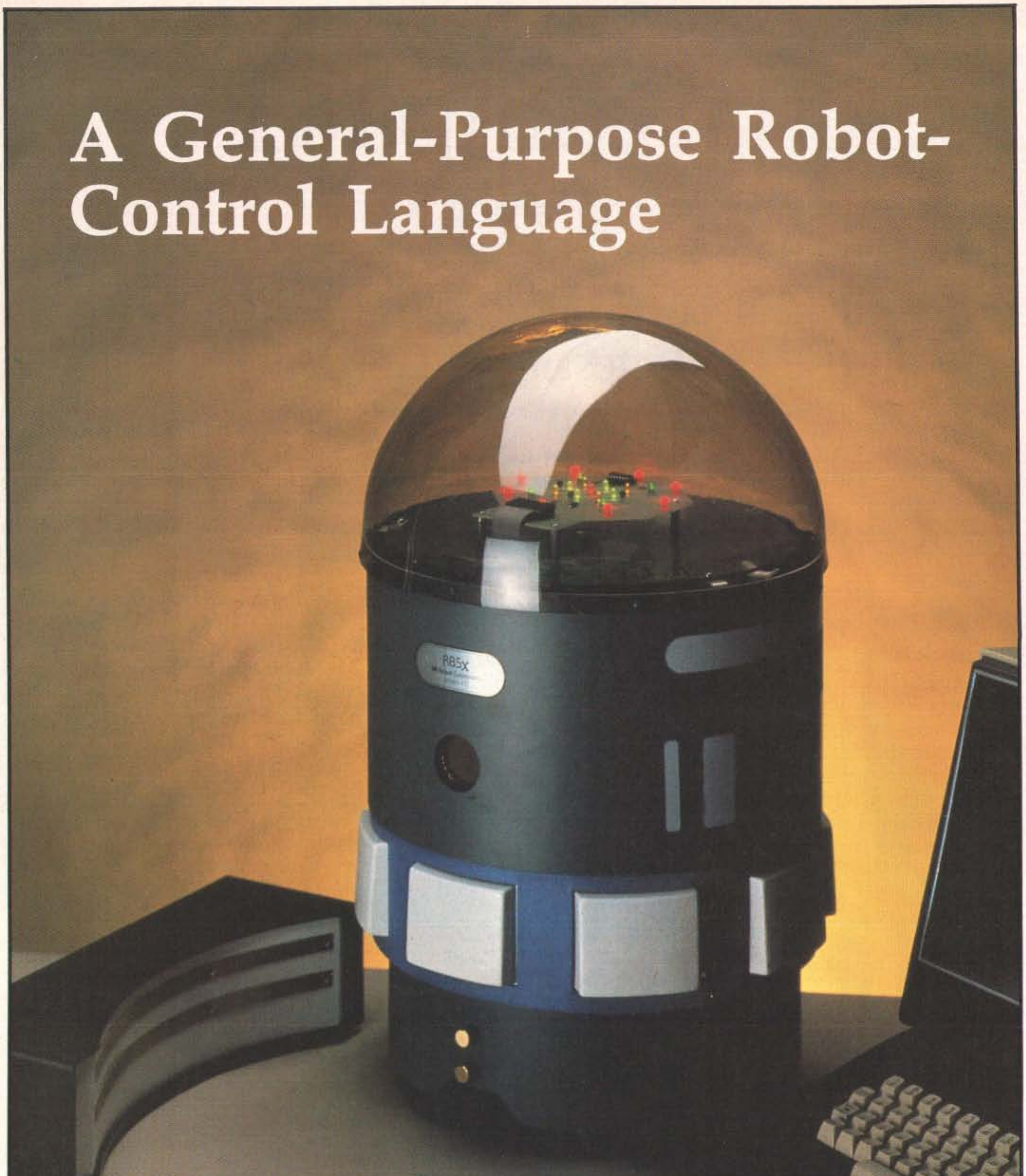
A General-Purpose Robot-Control Language



A plain-language system called Savvy simplifies talking to RB5X

by Dan Prendergast, Bill Slade, and Nelson Winkless

RB5X is a little fellow, almost 2½ feet tall. He is cylindrical, available with or without an arm, and has a domed plastic top (see photo 1). With two powered-drive wheels and two casters for balance, he can pivot around his own center point, rotate 360 degrees within his own diameter, and move forward or backward at about 4 inches per second. He's equipped with a ring of bumper switches, a highly directional sonar system capable of sensing remote objects or barriers at distances ranging from 10 inches to 35 feet. Infrared sensors under his body can detect markers on the ground, including a line that guides him to a charger at which he feeds his two sealed lead-acid batteries (see photo 2).

RB5X is a personal robot, the first in a series under development by RB Robot Corporation. RB5X is an example of state-of-the-art personal robots now reaching the market for the first time.

The robot can be fitted with a vacuum cleaner (see photo 3), a trailer, a voice, a compass for navigation, and even a fire detector and extinguisher. With speech-recognition equipment, RB5X can come when called and respond to useful spoken commands.

Notably, the robot is designed for growth. This initial design uses an INS-8073 8-bit processor from National Semiconductor with Tiny BASIC in ROM (read-only memory) and 8000 bytes of RAM (random-access read/write memory) to program control of the robot. Memory can be expanded with another 16,000 bytes of RAM, plus 4K-byte EPROM (erasable programmable ROM) cartridges for prewritten programs. The system motherboard provides several slots for expansion. Options as well as additional plug-ins developed by RB Robot and other companies are all designed to use this bus.

Robots, even more than mass-marketed computers, are expected to communicate with people in a convenient and friendly style. RB5X's programming language, Tiny BASIC, has some good features and packs a lot of power in a very small package, but convenience and friendliness with nontechnical strangers cannot be counted among its good features. For example, to sound the robot's horn, it's necessary for a programmer to type an instruction such as @#7801=#80. To make the horn stop, a different instruction is needed. This isn't what the average person has in mind for conversation with a robot. When we designed RB5X, we knew that a natural language for control of robots would be essential to their general acceptance in society. The open question was, "How soon could it be done?"

Robots, even more than mass-marketed computers, are expected to communicate with people in a convenient and friendly style.

The first steps were taken with remarkable speed. In June of 1983, the RB Robot staff examined a software system called Savvy developed by Excalibur Technologies Corporation. This system showed that the state of the art in plain-language programming and communication with computers had moved faster than anticipated. Even in its first release, Savvy offered a way to leap almost immediately from communication exclusively in computer code to communication in plain language.

We do not intend to do a full exposition of Savvy in this article. (The Savvy programming language will be reviewed in the February BYTE.) Briefly, the Savvy system integrates a computer operating system, an indefinitely extensible computer language, utilities, and applications.

Savvy is integrated with an adaptive pattern-recognition process (APRP) that lets it determine and act upon the *meaning* of imprecise inputs, program names, or instructions. For example, if Savvy has been programmed to recognize the instruction BLOW THE HORN, it will without further training recognize such mistyped or rephrased instructions as BLWO YOUR HRON, BLWO THEH ORN, etc.

Any specified input can be connected in Savvy with any specified output. Thus, the Savvy system can be trained so that if it sees a pattern that seems more like BLOW YOUR HORN than anything else, it should output the instruction @#7801=#80. Furthermore, Savvy can learn that HONK and SOUND WARNING SIGNALS and OBLAY DER ORNHAY all mean BLOW YOUR HORN. If you then type SOUND THE HORN, the correct Tiny BASIC code will be emitted.

RB Robot contracted with Excalibur for development of a new robot-control language (RCL) that uses the Savvy system on the Apple II computer. Programs are written in plain language, then automatically cross-compiled into Tiny BASIC code that is downloaded into the robot's computer.

Working in RCL with Savvy, a programmer of RB5X doesn't need to remember whether the command to move forward is @#7802=#9 or @#7801=#20; he simply types MOVE FORWARD.RCL is more than a simple substitution of English words for computer code. The programmer can at any time add to the RCL vocabulary. In fact, the programmer creates a new language in using the system; he not only adds synonyms to the existing commands but creates new commands and extends the language as far as desired.

If the operator writes a routine in RCL that causes the robot to run in a circle, the name of that routine (probably RUN IN CIRCLES or MAKE A CIRCLE) becomes part of the RCL vocabulary. RUN IN CIRCLES becomes a command with

Photo 1: *RB5X, a personal robot, standing next to the "charger/nest." When the robot finds the nest, the two metal contacts on the front make contact with the metal strips of the curved surface of the charger and recharge the robot's batteries. (Photos courtesy of RB Robot Corporation.)*

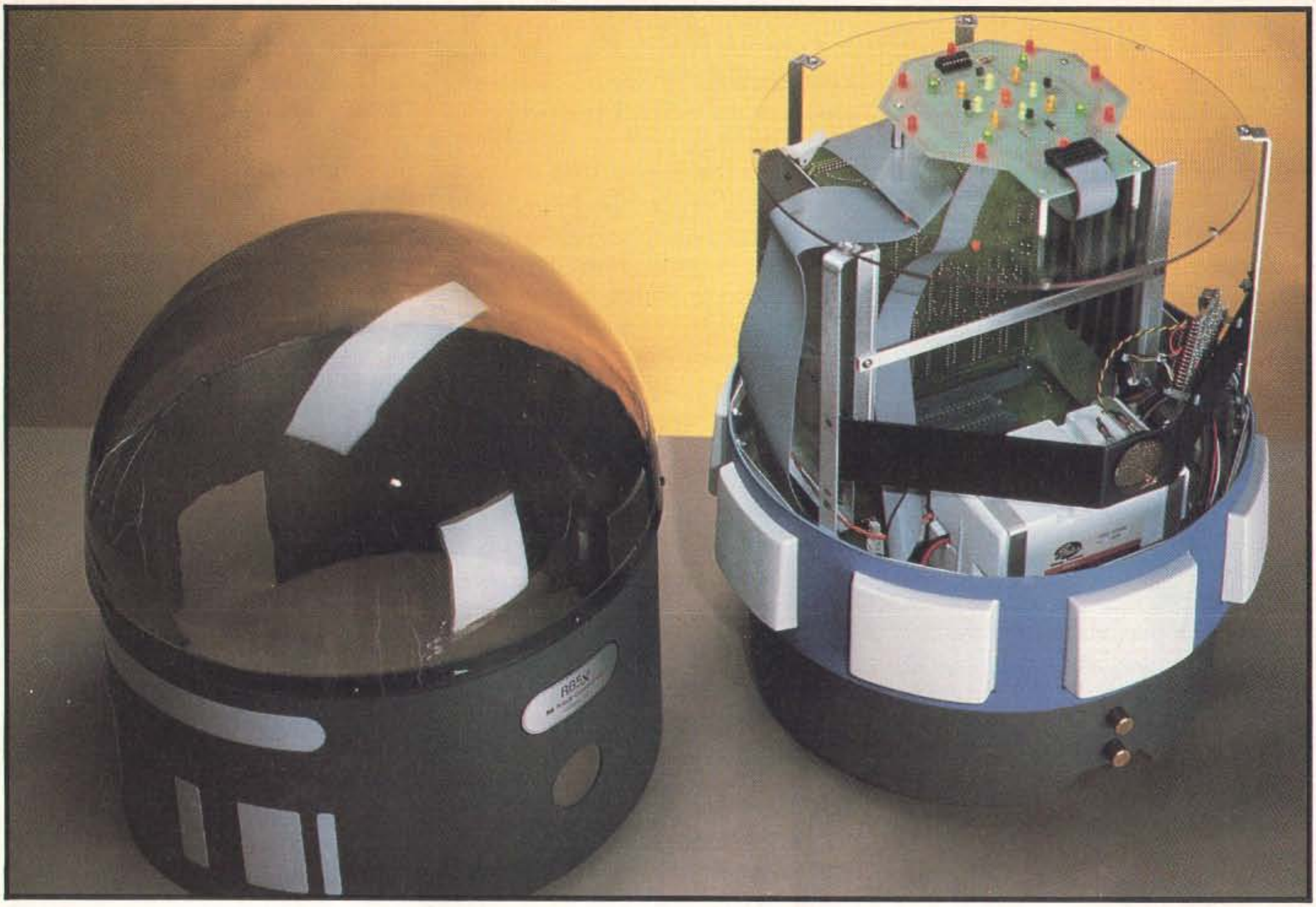


Photo 2: *An internal view of RB5X that shows the main circuit board and rechargeable batteries.*

as much authority as any Savvy primary-language command like ADD, EDIT, or SAVE. Perhaps the operator wants the robot to do a dance while humming its own tune. The robot may be instructed to MOVE FORWARD, then RUN IN CIRCLES, then MOVE BACKWARD. It is unnecessary to tell the computer to go and find the subroutine called RUN IN CIRCLES, fetch it, and then run it. The name of the routine itself, RUN IN CIRCLES, implies all that, and Savvy does it automatically without requiring detailed instructions.

You can think of Savvy as an automatic programmer that knows all of the details about the computer system. It tells the computer how to accomplish the steps of the task, specifies memory allocation, data types, linking, and blocking. Savvy tells the computer when to open and close files and how to move through the structural hierarchy from one point in the system to another. Savvy knows more about the internal operations of an Apple or IBM Personal Computer system than most human programmers. It follows the step-by-step instructions of a human programmer to code the program.

Savvy and a programmer must be able to communicate. RCL is the vocabulary created to enable that communication. If any wording choice seems unbearably bad to any RCL user, that person can associate some preferred name with the bad one and use *that*. To each his own.

Skilled programmers, proud of their ability to operate in obscure codes, may choose to give RCL an efficient vocabulary of very short names. You might teach the system that MF means the same as MOVE FORWARD, MB, MOVE BACKWARD, and RIC, RUN IN CIRCLES. Using this kind of technique does not necessarily hide the meaning from newcomers to the code. Savvy interprets each command in terms of its original, underlying vocabulary. Unless the programmer takes steps to obscure the meaning of the program (which can be done), the program task is ultimately documented by the system in plain text.

The vocabulary is constantly expanding because new fundamental instructions are continuously being added to the system for operation of the arm and hand, sensory systems, and other peripherals. The RCL programmer can add instructions, updating the system at any time, simply by defining the new terms to the system. RCL users will often develop new fundamental instructions that seem useful to them and add them to their own systems. No users group has yet been formed to publish and maintain a dictionary of terms common to all RCL users, though such action would facilitate standardization from system to system.

Developing RCL was essentially a job of writing a compiler as an application program in Savvy. The mechanics of the system were determined by the nature of the existing Tiny BASIC software and hardware. The National Semiconductor microprocessor, memory, and supporting circuitry are packaged specifically as a Tiny BASIC engine.

The goal in developing RCL was straightforward: create a plain-language programming environment that will let a user readily create and edit "scripts" to govern a robot's behavior. We did *not* want to limit the effective utilization of all of the hardware features of RB5X, and we wanted to make good use of Tiny BASIC. We aimed to create a flexible, easily extensible set of programming constructs.

The INS-8073 directly supports an RS-232C port through which a terminal can communicate with the Tiny BASIC interpreter/monitor in the RB5X. It was clear that with a correctly functioning robot, we didn't need two-way communication with Tiny BASIC. We could work just one way, downloading a program from the Apple to the robot.

Communications resolved, the next concern was storage of the Tiny BASIC program text. The typical syntax of a BASIC statement is statement numbers and then statement text. Therefore, a program file folder was named SOURCE, which had as its indexing item STATEMENT NUMBER and the two items BASIC TEXT and MEANING. BASIC TEXT is the program statement, and MEANING is a diagnostic and educational remark for the user.

By way of clarification, Savvy terminology, as well as structure, is somewhat different from convention. Savvy uses the word *folder* for what is commonly called a "file," *page* for "record," *item* for "field," and *task* for "program." (Yes, there is debate about this, but we'll not enter it here.)

The folder structure for stored Tiny BASIC text in RCL is:

```
SOURCE (a folder)
1 Id     STATEMENT NUMBER
2 Item   BASIC TEXT
3 Item   MEANING
```

Each robot script is, in fact, a Savvy task and is edited by the Savvy task editor. The "primitive" programming elements of RCL are the kinds of commands we suggested above. For example,

```
GO FORWARD
SPIN RIGHT 90 DEGREES
WAIT this many seconds <1>
TURN ON HORN
SAY this phoneme <1>
```

From these discrete instructions, the Savvy task editor compiles the Tiny BASIC text necessary to accomplish the function specified.

Here is the process for compiling a single line of Tiny BASIC: Increment the current line number to form the STATEMENT NUMBER for this statement, copy the appropriate piece of text to the BASIC TEXT, copy any meaningful text description to the MEANING, and then save this page of data in the SOURCE folder. Two tasks have been written to accomplish this compilation:

```
INCREMENT STATEMENT
    NUMBER (a task)
1 Does ADD the STATEMENT
    NUMBER and STATEMENT
    NUMBER INCREMENT VALUE
2 and COPY from SUM to
    STATEMENT NUMBER
3 and END

COMPILE the BASIC statement
    <1> which means <2>
    (a function)
1 Does INCREMENT STATE-
         MENT NUMBER
2 and  COPY from (1) to BASIC
         TEXT
3 and  COPY from (2) to
         MEANING
4 and  SAVE new page in
         SOURCE
5 and  END
```

With these two tasks, it's easy to write one-liners to compile a statement. Some RCL primitives are very simple. For example, STOP ALL MOTION (a task) does a COMPILE of the BASIC statement @#7802=#0 (which means STOP ALL MOTION). In another example, the primitive WAIT goes through logic to determine if a specified waiting period is shorter than one second. (In many

Text continued on page 130

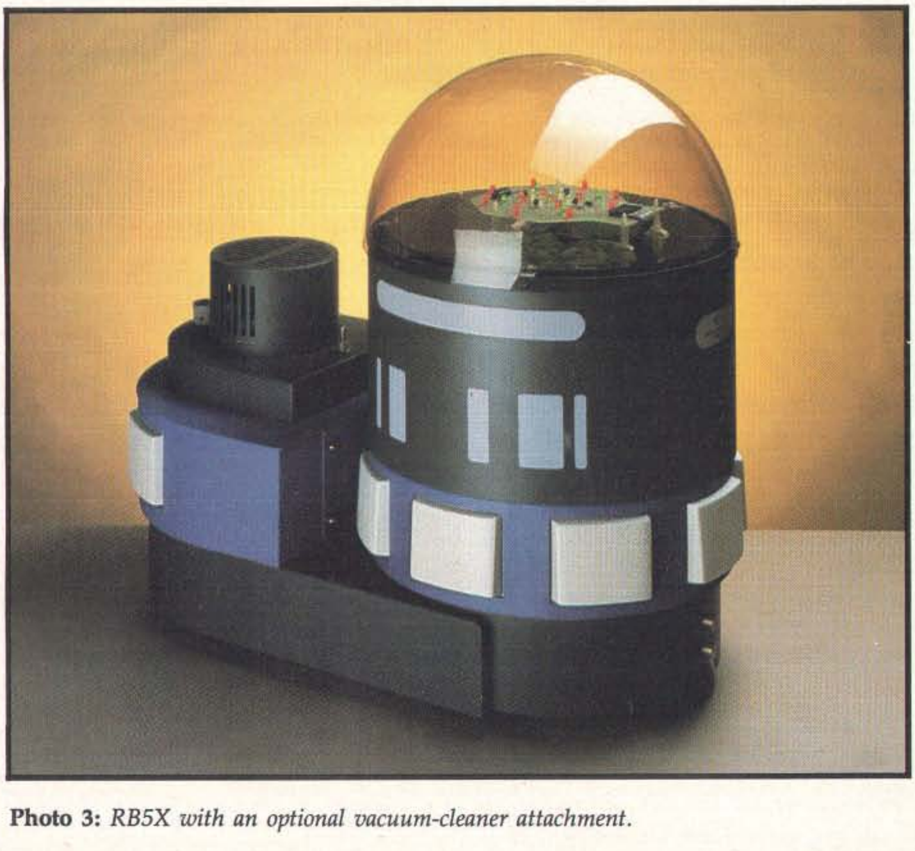


Photo 3: *RB5X with an optional vacuum-cleaner attachment.*

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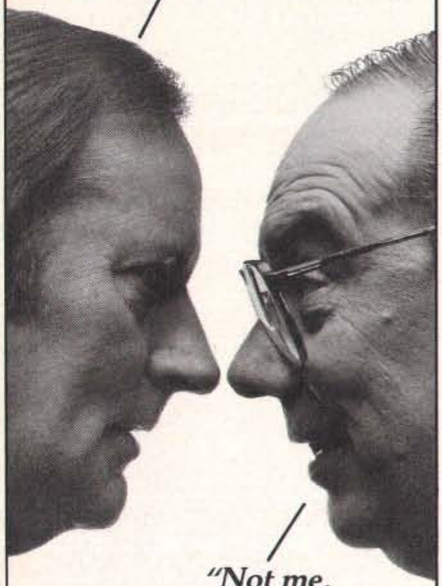

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Listing 1: *The Charger Finder routine written in RCL with Savvy. The program instructs the robot to search for a metal tape on the floor and follow that tape to the "charger/nest."*

```
 1 RESET THE ROBOT
 2 INITIALIZE MEMORY
 3 BEGIN A REPEATING PROCEDURE
 4   INITIALIZE MESSAGES
 5   CLEAR ALL VARIABLES
 6   BEGIN A REPEATING PROCEDURE
 7     GO FORWARD
 8     LEAVE IF ANY BUMPER TOUCHED
 9     DOES THE variable R compare = to ZERO
10       LEAVE THIS REPEATING PROCEDURE
11       END TEST
12     REPEAT THIS REPEATING PROCEDURE
13   LEAVE IF TAPE IS SENSED
14   MOVE WITH BETA INTELLIGENCE
15   REPEAT THIS REPEATING PROCEDURE
16 FOLLOW TAPE
17 MAINTAIN CHARGE
```

Listing 2: *The Charger Finder routine compiled into Tiny BASIC code. This program is transferred from the Apple II computer into the RB5X's on-board computer.*

Tiny BASIC Text	Meaning of Text
10 T = 10	Number of whole seconds
20 GOSUB 1000	Go wait
30 T = 10	Number of whole seconds
40 GOSUB 1000	Go wait
50 @#7803 = #98	Initialize I/O
60 N = TOP	Initialize experience block
70 O = TOP + #FF	Initialize inhibition block
80 M = TOP + #200	
90 FOR P = N TO M	
100 @P = #FF	
110 NEXT P	
120 REM START A LOOP	Begin A Loop
130 @#7803 = #98	Initialize I/O
140 CLEAR	Clear variables
150 REM START A LOOP	Begin A Loop
160 @#7802 = #09	Go forward
170 Y = @#7800	Test for bumper contact
180 IF Y<255 GOTO 230	Exit if any contact
190 IF R<0 GOTO 210	Make a comparison
200 GOTO 230	Exit this Loop
210 REM END HERE	Fall through to here
220 GOTO 150	Repeat this Loop
230 REM EXIT TO HERE	
240 X = #02	Turn on LED 1
250 GOSUB 1100	Go turn on a bit
260 R = @#7802 AND #40	Test for tape sense
270 IF R = 0 GOTO 310	Exit if tape sensed
280 GOSUB 2000	Go to Beta Subroutine
290 REM RETURN GOES HERE	Return to here
300 GOTO 120	Repeat this Loop
310 REM EXIT TO HERE	
320 REM START A LOOP	Begin A Loop
330 @#7803 = #98	Intialize I/O
340 CLEAR	Clear variables
350 REM START A LOOP	Begin A Loop
360 @#7802 = #08	Right forward
370 X = #02	Turn on LED 1
380 GOSUB 1100	Go turn on a bit
390 R = @#7802 AND #40	Test for tape sense
400 IF R = 0 GOTO 440	Exit if tape sensed
410 Q = @#7802 AND #20	Test for charger contact
420 IF Q = 0 GOTO 440	Exit if charger sensed

Listing 2 continued on page 128

SORRY CHARLIE!

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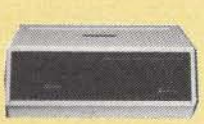

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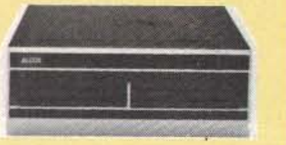

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Listing 2 continued:

Tiny BASIC Text	Meaning of Text
430 GOTO 350	Repeat this Loop
440 REM EXIT TO HERE	
450 Q=@#7802 AND #20	Test for charger contact
460 IF Q=0 GOTO 800	Exit if charger sensed
470 X=#40	Turn on flashing lights
480 GOSUB 1100	Go turn on a bit
490 T=0	Initialize
500 DO	Do the following
510 T=T+1	Math function
520 @#7802=#09	Go forward
530 R=@#7802 AND #40	Test for tape sense
540 UNTIL (R<>0) OR (T>=100)	Check exit conditions
550 DELAY 100	Short wait
560 @#7803=#98	Initialize I/O
570 CLEAR	Clear variables
580 REM START A LOOP	Begin A Loop
590 @#7802=#01	Left forward
600 X=#02	Turn on LED 1
610 GOSUB 1100	Go turn on a bit
620 R=@#7802 AND #40	Test for tape sense
630 IF R=0 GOTO 670	Exit if tape sensed
640 Q=@#7802 AND #20	Test for charger contact
650 IF Q=0 GOTO 670	Exit if charger sensed
660 GOTO 580	Repeat this Loop
670 REM EXIT TO HERE	
680 Q=@#7802 AND #20	Test for charger contact
690 IF Q=0 GOTO 800	Exit if charger sensed
700 X=#40	Turn on flashing lights
710 GOSUB 1100	Go turn on a bit
720 T=0	Initialize
730 DO	Do the following
740 T=T+1	Math function
750 @#7802=#09	Go forward
760 R=@#7802 AND #40	Test for tape sense
770 UNTIL (R<>0) OR (T>=100)	Check exit conditions
780 DELAY 100	Short wait
790 GOTO 320	Repeat this Loop
800 REM EXIT TO HERE	
810 GOSUB 2310	Charge maintain routine
1000 FOR S=1 TO T	Wait T seconds subroutine
1005 DELAY 1000	
1010 NEXT S	
1015 RETURN	
1100 U=@#7801	Turn on a bit @#7801
1105 U=U OR X	
1110 @#7801=U	
1115 RETURN	
1120 U=@#7801	Turn off a bit @#7801
1125 U=U AND X	
1130 @#7801=U	
1135 RETURN	
2000 P=@#7800	Bumper pressed
2010 IF P=255 THEN P=251	Sonar treated as bumper #1
2020 V=@(N+P)	Check experience block
2030 IF V<>#FF GOTO 2100	Try action
2040 V=RND(1,14)	Pick random action
2050 IF (V=3) OR (V=12) OR (V=(0+P)	Pick another
2100 @#7802=V	Try action
2110 T=2	Number of whole seconds
2120 GOSUB 1000	Go wait
2130 D=200	Cancel sonar test
2140 IF (@#7800<>#FF) OR (D<95) GOT	Not successful
2150 @(N+P)=V	Successful
2160 CLEAR	Clear variables
2170 GOTO 290	Back to main program
2200 @(0+P)=V	Not successful
2210 GOTO 2040	
2310 REM START A LOOP	Begin A Loop
2320 REM START A LOOP	Begin A Loop
2330 Q=@#7802 AND #20	Test for charger contact
2340 IF Q=0 GOTO 2560	Exit if charger sensed
2350 P=0	Initialize
2360 REM START A LOOP	Begin A Loop
2370 P=P+1	Increment Loop count
2380 @#7802=#09	Go forward
2390 DELAY 100	Short wait
2400 @#7802=0	Stop all motion
2410 Q=@#7802 AND #20	Test for charger contact
2420 IF Q=0 GOTO 2540	Exit if charger sensed
2430 IF P<>5 GOTO 2520	Make a comparison
2440 @#7802=#06	Reverse
2450 DELAY 1000	Short wait
2460 @#7802=#09	Go forward
2470 T=1	Number of whole seconds
2480 GOSUB 1000	Go wait
2490 DELAY 100	Milliseconds to wait
2500 @#7802=0	Stop all motion
2510 P=0	Initialize
2520 REM END HERE	Fall through to here
2530 GOTO 2360	Repeat this Loop
2540 REM EXIT TO HERE	
2550 GOTO 2320	Repeat this Loop
2560 REM EXIT TO HERE	
2570 X=#04	Turn on LED 2
2580 GOSUB 1100	Go turn on a bit
2590 DELAY 1000	Short wait
2600 @#7803=#98	Initialize I/O
2610 GOTO 2310	Repeat this Loop
2620 REM EXIT TO HERE	

END OF PROGRAM

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'Rover, Fetch a Dozen #9 Ratchets'

by Nelson Winkless

Personal robots have come a long way technically in the last few years. Advances in digital electronics have made it practical to build compact sensory, information-processing, and control systems that can ride in self-powered carts that aren't too large or heavy. The laboratory curiosities that have been rolling around research institutions and a few home workshops have become today's affordable "personal robots," loaded with potential. But potential for what?

A case has been made for using robots as household pets. They can be companions, health monitors, entertainers, communicators, and protectors, given a lot of hardware and software development that robot enthusiasts now are beginning to provide in increasing quantity. Pets are highly valued in our society, and the reasons for keeping dogs and cats around the house apply as well to keeping robots around the house. The discussion of pets is worthwhile, but let us not dwell on it here.

Our society prizes things that are specifically useful. Robots will fare well if they do useful work for people. Personal computers now do work for people, and businesses have no trouble finding excuses to buy them. Individuals have more difficulty finding excuses; games are a weak excuse, keeping personal accounts is fairly feeble, but word processing is pretty good. Robots offer even fewer practical excuses for their purchase, but their potential in the long run exceeds that of personal computers.

Just as the definition of the "personal" computer remains cloudy, the definition of "personal" robot is shrouded in uncertainty. Indeed, while we have pretty well agreed on what a computer is, we have by no means agreed on what a robot is, so the definition of a personal robot is doubly obscure. Without pretending to settle matters, I've come up with some guidelines for distinguishing personal from nonpersonal robots. But first we must talk about computers.

Before personal computers came among us, we had only institutional computers. They were owned by government agencies, large businesses, and other organizations. The work produced by the institutional computer is looked upon as the work of the organization. The personal computer, however, is looked upon as the implement of an individual. That person uses the computer as if it were a pencil, a pocket calculator, or a telephone. The individual, not the organization, is responsible for the work produced by that personal instrument, even when the individual is operating in an institutional setting. There's no ceremony involved in using the personal computer, no labored allocation of resources, no meetings, no sign-offs (that is, after the initial effort to get the computer). The individual uses the machine as casually as a pad of paper and is fully responsible for what is produced.

The institutional robot is typically part of a production system. The machine's work can be changed by changing its program, but it is used as part of a larger scheme, worked out and administered by an organization. The personal robot will be identified with an individual who is responsible for its actions, misbehavior, and good deeds. The individual will get credit and blame for its performance, as does the user of an Apple. (Am I my robot's keeper? Yes.)

Personal robots represent the convergence of two lines of technical development—automobiles (in the sense of "self-moving" systems) and computers. You might think of personal robots as mobile machines to which we are now finally adding flexible automatic guidance and control systems. You might think of robots primarily as computers that can move around. You might also think of them as artificial animals, neither vehicles nor information handlers but self-serving systems that interact with their environment in a way that enables their own survival; in essence, a new class of machine.

What practical excuse can we find for getting acquainted with personal robots? Well, let's go back to "automation."

Technologists have been working on factory automation for a long time and making good headway. The automated office began with word processors, communications equipment, personal computers, etc. Office automation has been most effective in small enterprises, where one personal

Text continued from page 125:

robot scripts, RB5X is instructed to wait for a specified period of time before going on to the next action.) If the period *is* shorter than one second, RCL computes a "DELAY *nnn*," where *nnn* is in milliseconds. Otherwise, it calls an integer second delay subroutine and, if necessary, compiles a DELAY for any fractional period.

This is the general model for implementing primitives of RCL. Of course, many primitives are provided to the RCL user, so the casual robot user needn't get down to that level. The next higher level of RCL primitive is exemplified by:

HONK the horn for this many seconds <1>
1 Does TURN ON HORN
2 and WAIT this many seconds <1>
3 and TURN OFF HORN
4 and END

Again, we are not attempting here to provide a complete explanation of Savvy. We're merely showing the approach to using Savvy in RCL to compile Tiny BASIC. Let us reiterate that the casual RCL user never sees the compiled Tiny BASIC code unless by choice. Indeed, he never has to see the comparatively plain-language Savvy tasks. The whole point of RCL is to give the robot operator a simple means for telling RB5X what to do. The mechanism outlined above does that.

By way of demonstration, the 17-line RCL routine in listing 1 compiles the 262-line Tiny BASIC routine in listing 2. RCL with Savvy is new and will clearly never be "complete," but it serves its immediate purposes well, and RB Robot is developing applications programs in RCL to put RB5X through a lot of paces.

computer, such as an Apple, serves many functions: production scheduling, word processing, bookkeeping, inventory control, mailing-list management, and so forth.

In the shop or office, the personal robot can become a strange combination of uncomplaining menial and brilliant informant. Imagine a scenario along these lines: You're running a small assembly plant. Ten or 15 workers take components, assemble them into your products, package them, and ship them to customers. The business is not very complicated, but it depends upon alertness, responsiveness, quality control, and a smooth flow of production. You add a robot to the staff. Give it a name, something neutral to avoid social conflict. Call this machine "Rover."

Rover learns the layout of the shop, the schedules, the identities of other employees, the social hierarchy, the protocols (who gets out of whose way), and the rhythm of the place.

People tend to drop small components. In many cases, it's cheaper to toss out the dropped stuff rather than collect and resort it. Rover, however, can wander around, pick the pieces up, and put them away without any stir. This saves material, breaks in the routine, dignity, and possibly the job of an otherwise good employee who is having a spell of dropping things.

"Hey, Rover, bring me a dozen #9 ratchets." Rover can. "Rover, take this up to Norma in the front office and come right back." Rover will. "Rover, let's take inventory." And at this point, the robot can do some things that people can't do. Not only should Rover be able to trail around after you, counting things, holding things, and recording information; Rover should have the complete inventory system in mind and be able to comment on discrepancies, looming shortages, and changes in rates of use. Indeed, Rover should have free access to the inventory and order information handled by the computer in the front office. Rover should know which orders are in the works, which items are back-ordered, and which are in oversupply. Rover should have, and he should be able to communicate, all of the complex detail that the shop manager cannot practically keep in mind. Also, Rover should be perfectly willing to sit up all night with the inventory chores, sorting, counting, tidying, and making burglars nervous.

"Rover, get the phone." The robot should be able to handle calls at least as well as the average answering machine, and might even select among callers. ("If Mr. XYZ calls, let me know at once.") Furthermore, Rover can carry the phone to you.

"Rover, I want to send a letter." Rover should be able to plug in the keyboard and the display for word processing and have them ready when and where you want them.

"Rover, has ABC Products ever bought a Model Six from us?" The robot can be a good database manager, offering state-of-the-art facilities in Natural Query Language for communicating with you. Indeed, the robot can be loaded with information and manipulate it on the spot if a keyboard and display are available.

Rover becomes a useful hand around the place, learning to do whatever is appropriate at the moment and remembering how to do that same job again later. With experience, Rover grows increasingly valuable.

With the personal robots currently available, how practical is this scenario? Not very. Some of Rover's activities can be done by commercial personal robots right now. But how practical was an MITS Altair computer with octal switch input, 4K bytes of memory, cassette storage, and no BASIC? Not very. A few years of serious effort were needed to shape personal computers into generally useful devices.

The same kind of effort will make personal robots handy. We've come a long way already. The availability of a plain-language control system brings Rover-like performance closer to reality. Memory is getting cheap, speech recognition and synthesis are operating at a useful level, sensory systems can be integrated nicely, and some clever mechanical systems exist.

You may want to tell your personal robot to fetch the paper and do those entertaining things around the house that we consider suitable activity for personal robots. You may also want to tell it to knock out a day's useful work in the shop.

The robots are willing; we have to learn how to tell them what we want.

Summary

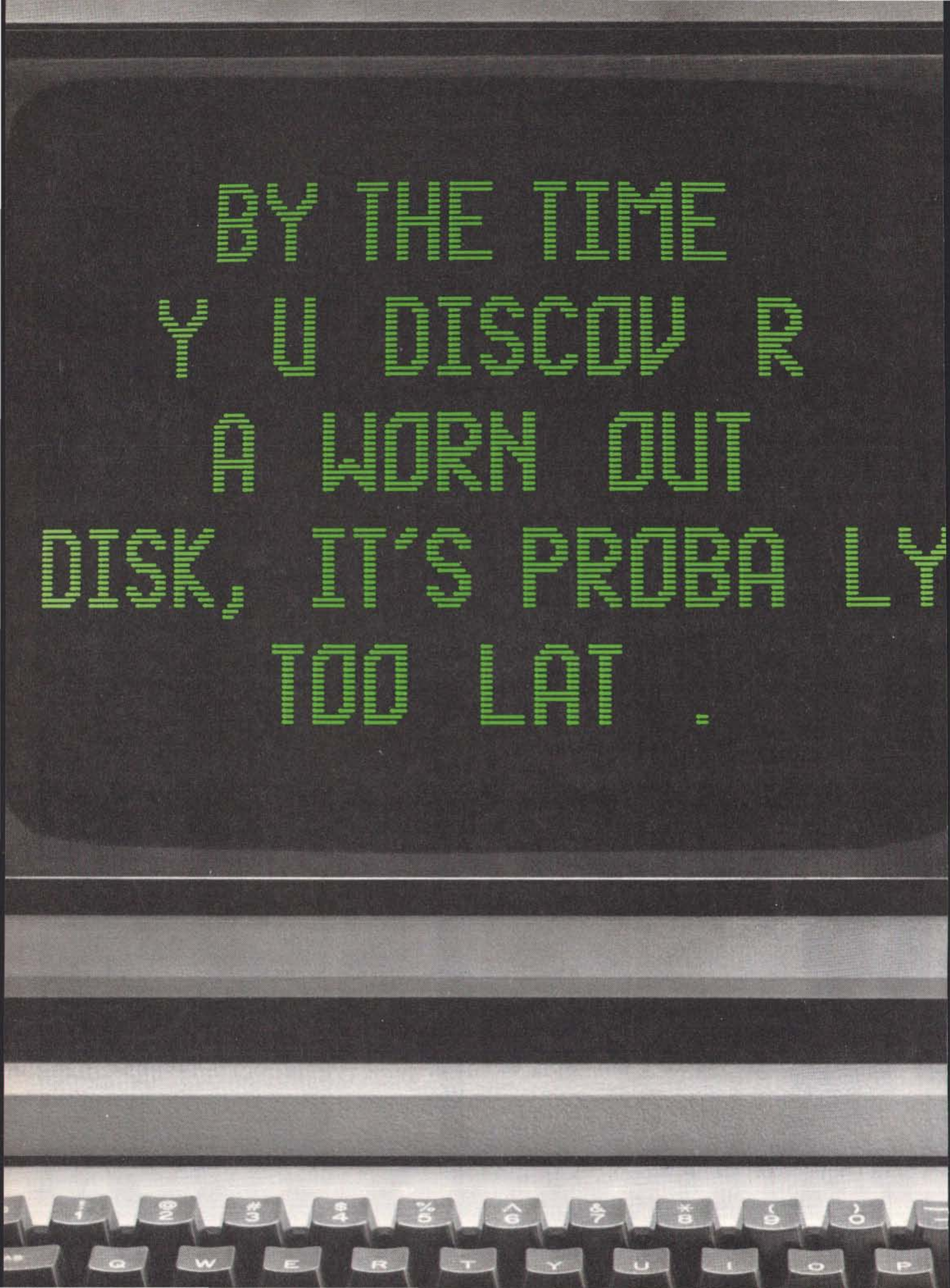
RCL and Savvy mark an improvement over Tiny BASIC coding, of course, but an improvement on Tiny BASIC alone is a modest goal. The programmer (and the robot) are still dependent on programming generated on an external computer and downloaded to the robot. Obviously, RB5X needs more brains aboard, and a card is in development that will enable programming in RCL internally in RB5X. Also, sensory input patterns can be learned by a Savvy system and associated with appropriate responses. RCL will become more comprehensive with time and experience, and the system can be extended in many directions.

This has important implications for robotics. One intriguing thing about RCL is that it could work from the same plain-language instructions to compile programs in any language—FORTRAN, assembly language, whatever the object machine wants to hear. An enriched RCL vocabulary could control milling machines and steel mills as well as RB5X and his brethren. RCL with Savvy in its first release is powerful. It seems capable of becoming a general-purpose robot language that can keep up with the state of the art.■

Dan Prendergast is vice-president of research and development at RB Robot Corporation, Bill Slade is operating-systems manager at Excalibur Technologies Corporation, and Nelson Winkless is president of ABQ Communications Corporation (Box 1432, Corrales, NM 87048) and coauthor of Robots on Your Doorstep.

The RB5X robot is manufactured by RB Robot Corporation, Suite 310, 18301 West 10th Ave., Golden, CO 80401, (303) 279-5525.

The Savvy Programming Language is published by Excalibur Technologies Corporation, POB 26448, Albuquerque, NM 87125, (505) 242-3333.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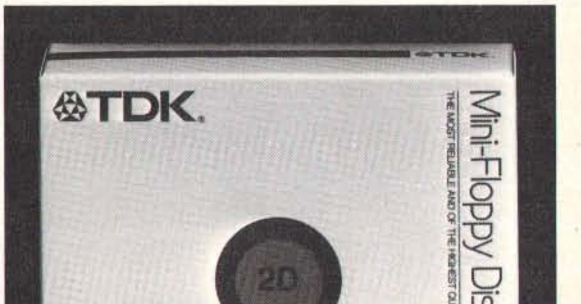
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1984, the Year of the 32-bit Microprocessor

Technological evolution continues at breakneck speed with the coming of the supermicroprocessor

by Richard Mateosian

By the end of 1984, we'll have seen 32-bit microprocessors manufactured by Data General Corporation (DG), Digital Equipment Corporation (DEC), Hewlett-Packard (HP), Inmos, Intel, Motorola, National Semiconductor, NCR, Western Electric, and Zilog. In this article, I'll look at what 32-bit microprocessors are and what they're going to be used for. Then I'll look at certain details available about the chips.

First, let's define our terms. A 32-bit microprocessor has a full 32-bit architecture, a full 32-bit implementation, and a 32-bit data path (bus) to memory. Because this definition is terse, some explanation and examples are in order.

Architecture. What is a microprocessor's architecture? The term means different things to different people but, for this article, let's call it the interface between the programmer and the machine. Architecture defines the set of accessible registers, the memory model, the instruction set, and the addressing modes of the machines. In order to qualify as having a full 32-bit architecture, the machine must have the following features:

1. Data and address registers that are 32 bits wide.
2. An instruction set that fully supports 32-bit data types.
3. Indexes and other address modifiers used in the machine's addressing modes that have 32-bit representations.

Now, I don't mean to quibble about a few bits here and there. For example, the DEC VAX, generally acknowledged to have a 32-bit architecture, devotes the uppermost bits of addresses to special purposes; the actual address fields are smaller than 32 bits wide. Furthermore, many 32-bit architectures provide for compact forms of addressing or address modifiers using fewer than 32 bits, but these are in addition to, not instead of, the full 32-bit forms.

Full support of 32-bit data types is another deceptively simple idea. At the very least, it means that 32-bit quantities can be moved with a single instruction, and the usual arithmetic and logical operations (e.g., ADD, SHIFT, NOT) can be applied to 32-bit operands to produce 32-bit results. Problems arise with multiplication and division operations. When two 32-bit quantities are multiplied, the result may have as many as 64 significant bits. Similarly, because division is the inverse of multiplication, you would expect, in a 32-bit architecture, to be able to divide a 64-bit quantity by a 32-bit quantity as long as the quotient and remainder could each be represented in 32 bits. One popular microprocessor, widely regarded as having a 32-bit architecture, limits multiplication to 16-bit quantities so that results can be represented in 32 bits. The same microprocessor enables division of a 32-bit quantity by a 16-bit quantity, but only if the quotient can be represented in 16 bits.

Implementation. It is easier to understand architectural anomalies such as those mentioned above in terms of implementation. The first 16-bit microprocessors (8086, Z8000, 68000) were implemented with 16-bit data paths and computational units, even though two of these microprocessors included many 32-bit architectural features. Similarly, Intel's iAPX432, which featured an innovative 32-bit architecture, was implemented with a 16-bit computational unit and 16-bit internal data paths.

Let's look at how implementation can account for the architectural restrictions I've just described. Suppose you are designing a microprocessor with a 16-bit computation unit (also known as an arithmetic and logic unit or ALU). That means that

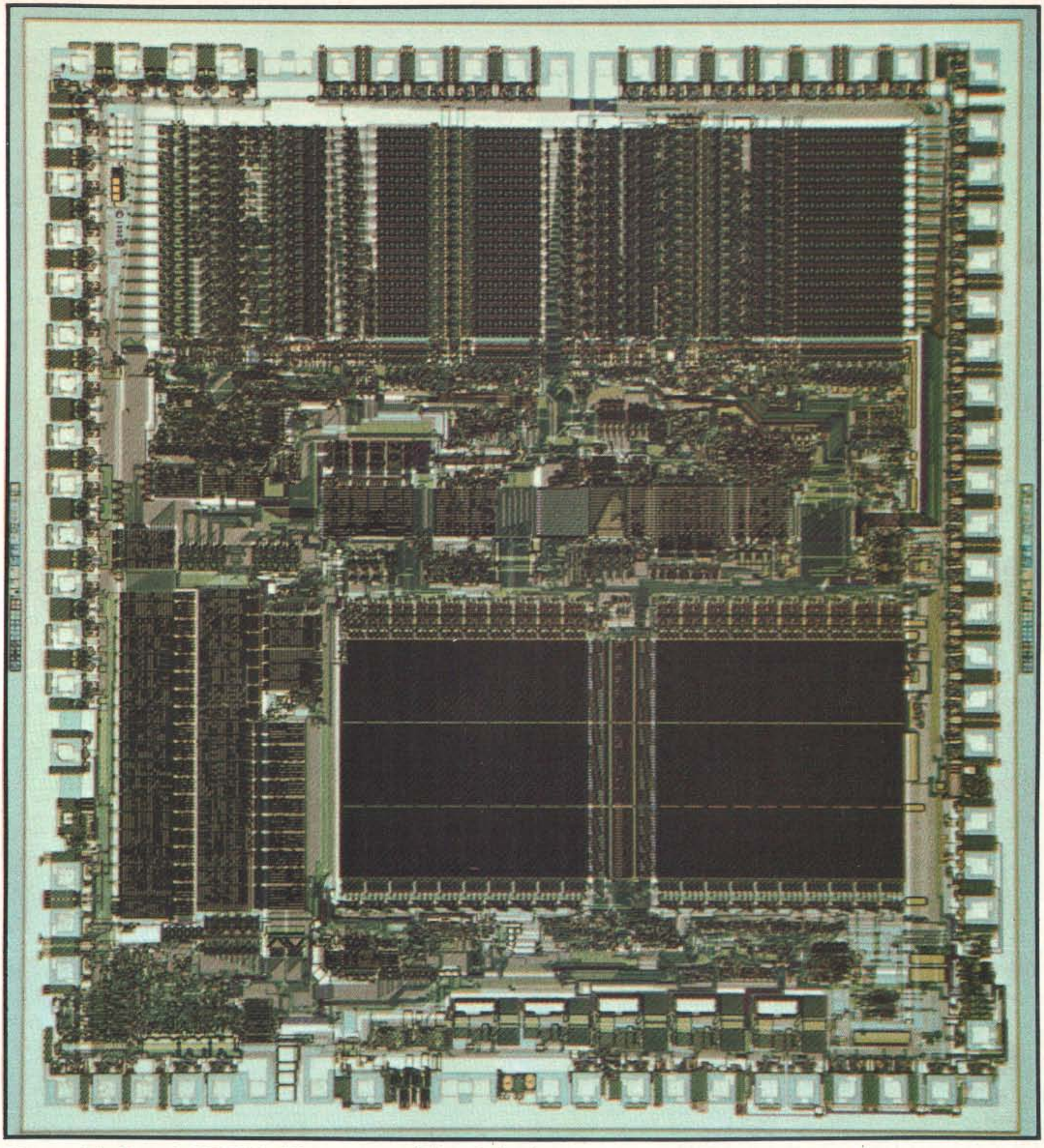


Photo 1: *The Motorola MC68010. (Photo courtesy of Motorola Inc.)*

a basic operation of the ALU will be to accept two 16-bit inputs and to produce a 32-bit product. If you want 32-bit registers and an instruction that multiplies two 32-bit quantities to obtain a 64-bit result, you're going to have to devise some sort of internal hardware "subroutine" that breaks the multiplication down into 16-bit multiplications and additions. These subroutines are an endless source of problems when you implement interrupt handling or virtual memory. They are not appreciably faster than subroutines in software that implement the same operations using basic ALU operations. Thus, you will be tempted to match the architecture to the implementation, putting in a multiplication restriction like the one mentioned earlier. This causes little inconvenience to customers, but it gives a marketing department nightmares when it tries to convince the world that a microprocessor has a true 32-bit architecture.

Data path (bus) to memory. This is

the easy part of the definition of 32-bit microprocessor. There must be 32 (or more) I/O (input/output) lines used for the transfer of data between the central processing unit and memory. The effect of this requirement is to increase memory-bus bandwidth (the amount of data that can be transferred on the memory bus per unit of time). In simple systems (just a central processing unit and memory), this can increase performance only when the central processor can handle instructions and data faster. In more complex systems, an important benefit of increased bus bandwidth is the ability to use multiple central processing units, direct memory access (DMA) transfers, and high-speed graphics processing without degrading computational power. By using the bus substantially less than all of the time, a 32-bit microprocessor contributes to overall performance in computer-aided design (CAD) systems, engineering workstations, and even mainframe-level computers.

Data buses of the 32-bit type are a relatively new addition to the microprocessor scene. Chips like Intel's iAPX432 and National Semiconductor's NS16032 have full 32-bit architectures but 16-bit data buses. As this is being written, system designers cannot yet buy production quantities of any microprocessor with a 32-bit data path to memory.

What Are 32-bit Chips Good For?

The preceding section hints at the strengths of 32-bit microprocessors. The year 1984 will see many announcements of CAD systems and engineering workstations based on 32-bit microprocessors. General-purpose computers will appear with mainframe performance at substantially less than mainframe cost. High-end personal computers will follow. As competition and the "learning curve" of system design around 32-bit machines drive down prices, 32-bit microprocessors (and their architecturally compatible 16- and 8-bit relatives) will become the standard for business and serious personal computing.

Aside from the performance advantages that come from higher memory-bus bandwidth and 32-bit implementation, the main benefit 32-bit microprocessors bring to computer users is architectural. Most 32-bit microprocessor architectures are designed to support high-level language programming.

Each 32-bit microprocessor addresses the issue of high-level language programming in a different way, and we'll look at the details later in the discussion of individual products. The basic support features are: large, uniform address spaces; support for virtual memory; addressing modes that support high-level languages; and instruction-set symmetry with respect to operations, operand size, and operand addressing modes.

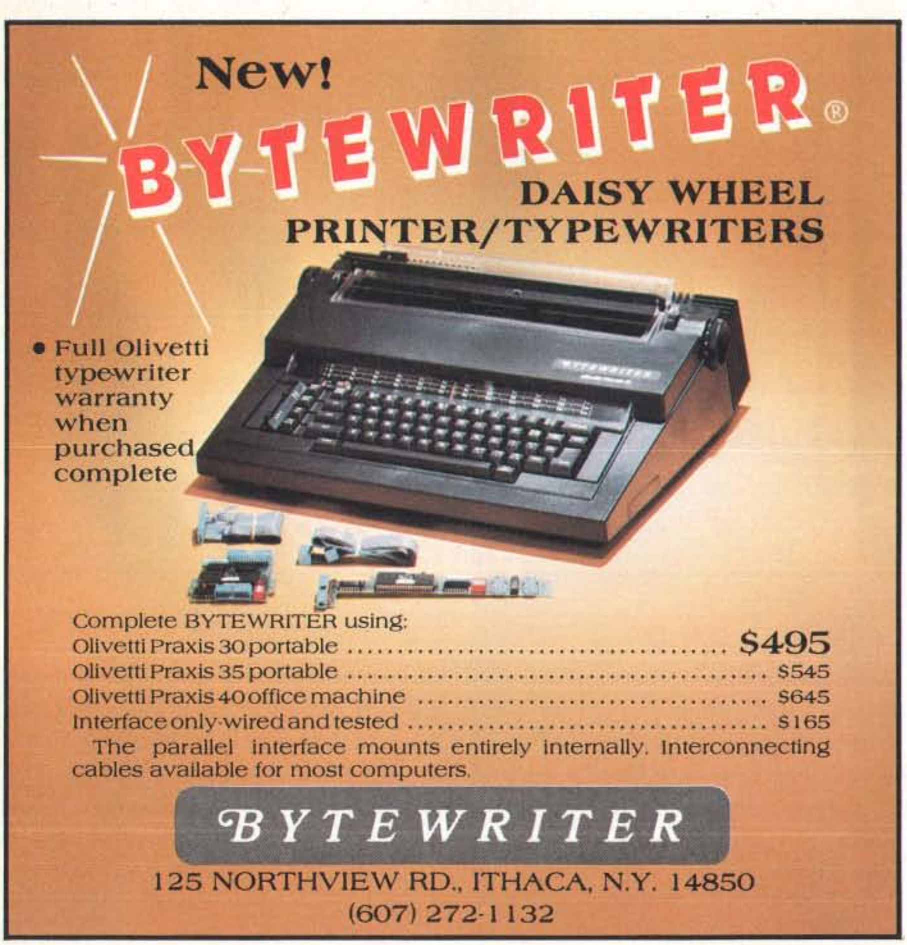
Another benefit of the features of the new microprocessors is that they can use standard operating systems. Advances in computer science have led to the inclusion of operating-system support features within the new architectures, and the existence of "standard" operating systems like Unix has made the design of specific support features easier.

The Lineup

I want to discuss every 32-bit microprocessor that will be available or announced this year, but this involves a little guesswork. Much of this information is based on official releases, technical articles, and reliable inside information. Other parts of the story are based on rumors, used only when that's the best information available, and then only when I believe the rumors.

Here (in alphabetical order by manufacturer's name) are the 32-bit microprocessors:

- DG's Microeagle
- DEC's Micro VAX 1
- HP's Focus (company's internal name)
- Inmos' Transputer
- Intel's iAPX386
- Motorola's MC68020
- National Semiconductor's NS32032



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- NCR's NCR/32
- Western Electric's WE32000
- Zilog's Z80000

DG announced its Microeagle in November 1983. DEC's Micro VAX 1 was announced last October. The HP Focus (no official name or part number) is the heart of the HP-9000 computer system, but it is not and will not be available as a separate product. The Intel iAPX386 has not been announced yet, but the company is expected to do so in late 1984. Motorola has announced its MC68020; although no detailed specifications are available, samples have been promised for the middle of this year. The NCR/32 chip set, like the National Semiconductor NS32032 and its associated chips, is commercially available. Western Electric has incorporated its WE32000, formerly known as the Bellmac-32 and operational since 1981, into at least one terminal. The chip, used internally by the company and in several VAX-class minicomputers, is not available as a separate product, but Western Electric has not publicly ruled out that possibility. Zilog's Z80000 has been announced, detailed specifications are available, and samples have been slated for release this year.

In addition to these products, there is an important experimental family of microprocessors called RISC machines. (RISC is an acronym for reduced-instruction-set computer.) These 32-bit microprocessors have been developed at universities like Stanford and the University of California at Berkeley. They are not commercial products, but the ideas propelling them will profoundly influence future commercial microprocessors. The Inmos Transputer, announced in November 1983, reflects this influence.

Now let's look at these microprocessors in greater detail. Then I'll make a few comparisons.

The DG Microeagle. This is a VLSI (very large-scale integration) version of the machine whose soul Tracy Kidder described. The Microeagle chip set's central processing unit executes register-to-register operations in a 400-nanosecond cycle time and uses two cycles for memory-to-register moves. The central processor uses a floating-point coprocessor to handle 64-bit addition in four cycles. (See the November 3, 1983 issue of *Electronics* for more information.)

The DEC Micro VAX 1. The VAX is a well-known 32-bit architecture that has been realized in two "supermini" implementations, VAX-11/780 and VAX-11/750, and in a more modest VAX-11/730 version. The Micro VAX 1 is an implementation of the same architecture in a set of VLSI circuits, supplied on a printed circuit board like the LSI-11 implementation of the PDP-11 architecture.

A key feature of the VAX line of computers is its total upward and downward compatibility. In this Micro VAX 1, some of the "commercial" instructions have been eliminated, but traps have been provided to enable their emulation in software. The VAX architecture is well known.

The Hewlett-Packard Focus. A number of articles have been published about the process technology and design methodology of the HP Focus, but HP deliberately avoids revealing details of the architecture. Enough is available from technical articles, however, to get the general idea.

Basically, HP set out to design a set of VLSI components that would work together to form fully integrated 32-bit multiprocessing systems. It took seven years; when HP finished, it had designed six VLSI circuits and a special mounting board that doubles as a heat sink. The six circuits are: central processor, I/O processor, memory controller, RAM (random-access read/write memory), ROM (read-only memory), and clock. Each circuit is fabricated in a 1-micron double-metal NMOS (negative-channel metal-oxide semiconductor) technology, designed to run at 18 MHz. A typical system block diagram is shown in figure 1.

The most complex of the circuits is the central processing unit, which contains about 450,000 transistors. Its 230 instructions are microcoded in 9216 38-bit words of control ROM, fetched and executed at an 18-MHz

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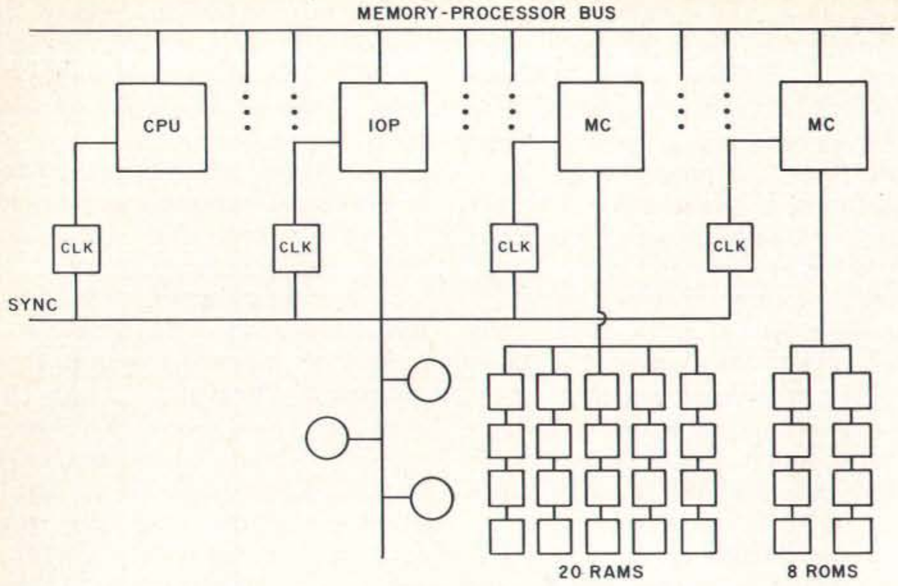

Figure 1: *A block diagram of the Hewlett-Packard Focus microprocessor.*

clock rate. A 38-bit microinstruction is executed every 55 nanoseconds. The central processing unit's instruction set is stack based, in the style of some Burroughs machines. Many instructions operate on the top elements of the stack, leaving the result on the stack. To optimize these instructions, the top elements of the stack are automatically kept in registers, with transfers between these registers and the stack segment of memory carried out without explicit machine instructions.

The central processor contains an extremely powerful ALU capable of executing a 32-bit register-to-register integer addition or a right or left shift of up to 31 bits in one microcycle (55 nanoseconds). Division of 64-bit operands in IEEE (Institute of Electrical and Electronics Engineers) format, the longest ALU operation, requires 16 microseconds.

The memory model for a process executing on the Focus central processing unit consists of code, stack, global data, and external data segments. Processes can have multiple data segments, which can be demand paged. Code is also demand loaded, an entire segment at a time.

HP estimates the execution speed of the Focus central processing unit to be approximately 1 MIPS (million instructions per second) on typical instruction mixes. That is, a typical instruction requires approximately 18 microcycles for its execution. Although execution and operand fetching from memory are pipelined, the central processor has no cache or TLB (translation lookaside buffer, a cache of address translations used for memory addressing). Nonetheless, the Focus central processing unit uses only about 30 percent of the 18-megabyte/second memory-bus bandwidth, so that substantial performance improvement can be obtained with a configuration that has multiple central processing units. This is exactly what HP intended, and the instruction set of the central processor is designed to support parallel processors.

The Focus instruction set features high-level language support, including a Try/Recover facility based on stack markers. The Focus is intended to be programmed in HP's "Modular Pascal" implementation language, Modcal. Even the lowest level of the company's HPUX (HP's version of Unix) kernel is programmed in Modcal.

I'm not going into detail about the other circuits of the Focus chip set, but one example shows how these circuits work together. The central processing unit can issue up to three addresses on its multiplexed address/data bus before receiving the corresponding data from memory. The data words appear on the address/data lines at precise, predictable times, requiring perfect synchronization of the activities of the central processor, memory controller, and memory circuits. In fact, 25 of the central processing unit's 83 "pins" are dedicated to control lines for communication with other Focus chip set circuits. (The remaining pins are the 32 address/data lines and the 26 lines for power, ground, and clock signals.)

The Inmos Transputer. This is a RISC-like machine scheduled for release in late 1984. The name of the chip indicates Inmos intends to make it as ubiquitous as the transistor. The Transputer will be a single-chip, 250,000-transistor device built in 2.0-micron CMOS (complementary metal-oxide semiconductor) technology. It will include processor, memory, and communications circuitry. The Transputer is designed to be used in multiprocessor systems and data-flow machines programmed in Inmos' Occam language.

The Intel iAPX386. Some of this information is based on rumors, but it's what I believe to be true about this chip:

- it's an extension of 8086 and 286 architectures
- it has 32-bit offsets in data segments
- it's implemented in CMOS technology to run at 16 MHz
- it has speeded up instructions from iAPX286
- it has an on-chip instruction cache
- it contains 270,000 transistors
- it features on-chip paging plus 286-style segmented virtual memory
- it has new instructions for vectors and bit fields
- its accompanying numeric coprocessor is much faster than the 80287
- its improved bus supports fault tolerance

The Motorola MC68020. This is the 32-bit member of the MC68000 family. Very little has appeared in print about the features of this central processing unit, which is scheduled to be sampled in 1984. Motorola personnel have talked freely at recent conferences and trade shows, and many details have been presented to current 68000 users. I'll summarize the industry scuttlebutt about the

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68020.

The MC68020 is a 32-bit version of the widely used MC68000. It is basically upward compatible—most 68000 code can run on a 68020, but not vice versa. Because the 68000 architecture has already been presented in a series of articles by Tom Starnes (April, May, and June 1983 BYTE), I'll concentrate on the improvements.

Although most of the instruction-set changes are in the area of addressing, specific new instructions have been added for packing and unpacking of BCD (binary-coded decimal) strings, manipulation of bit fields, and 32-bit multiplication and division. Several new addressing modes have been added, and 32-bit displacements are supported.

Because the 68020 maintains the 68000 requirement that instructions be multiples of 16 bits in length and aligned on 16-bit boundaries in memory, extensions to 68000 addressing involve the addition of one or more 16-bit words to the basic instruction. This additional space makes possible the encoding of a large number of new addressing forms. These forms include 16-bit and 32-bit displacements, elimination of the base or index register operand in addressing modes that usually require one, and an additional level of indirection, either before or after indexing.

Besides instruction-set changes, the 68020 has a number of other new features. The most important are an on-chip instruction cache, dynamic bus sizing, a coprocessor interface (to support the MC68881 floating-point coprocessor), better exception handling, virtual memory and bus fault support, and a "barrel shifter" to speed the execution of shifts, multiplication and division, bit field, and other instructions.

The 68020 will be fabricated in a new process that is about 90 percent CMOS, with NMOS technology used for critical circuits. The chip contains approximately 170,000 transistors and will be supplied at speeds of 16 and 20 MHz. Motorola estimates that at equal clock speeds, the 68020 will be about twice as fast as a 68000 on typical programs.

The National Semiconductor NS32032. This is the 32-bit member of the NS16000 family, which consists of the NS08032, NS16032, and NS32032. The NS08032 and NS16032 are the 8-bit and 16-bit bus versions. As in the VAX line, all central processing units in the NS16000 family share the same 32-bit architecture. Except for the data bus, they also share the same internal implementation. BYTE readers had the opportunity to learn about the NS16000 family architecture in an article by Glen Leedy (April 1983, page 53), so I won't repeat that material.

The NS16000 family is distinguished by its mainframe-on-a-chip architecture, featuring virtual memory, floating-point support, and a highly regular, compactly encoded instruction set designed for high-level language support. The NS32032 is designed to work with a memory-management unit (MMU), the

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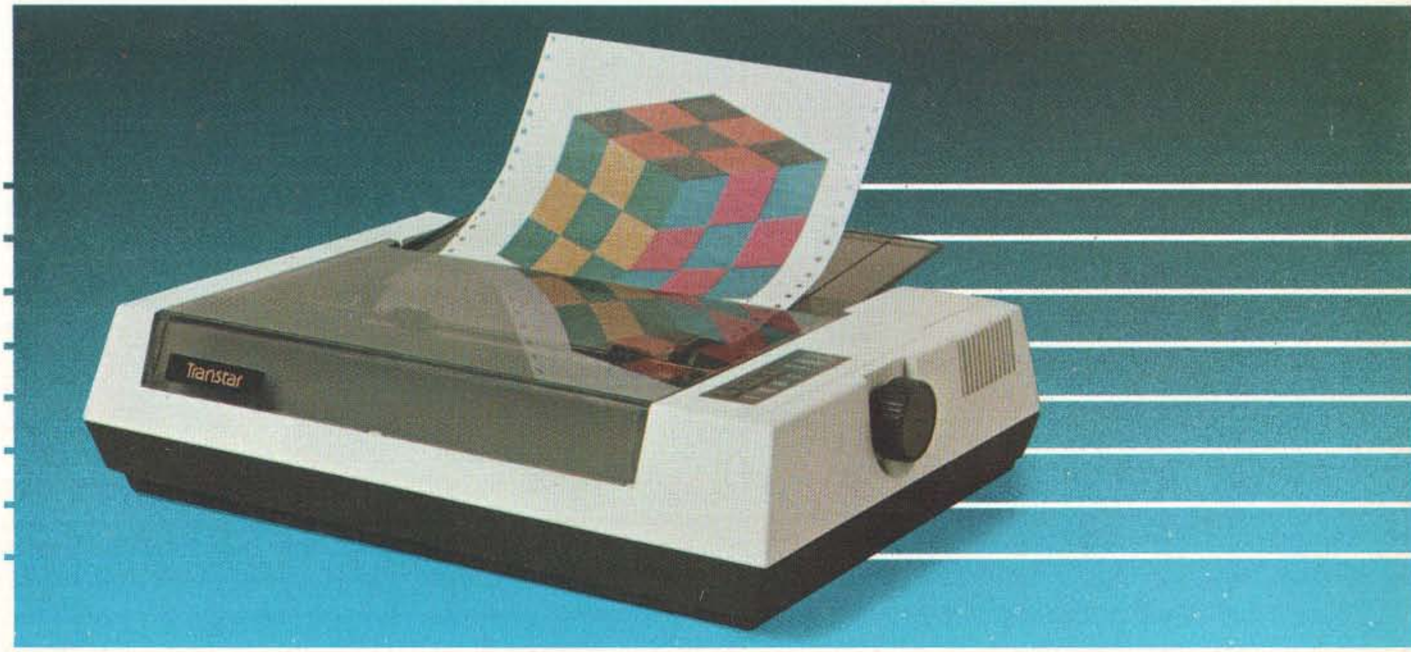

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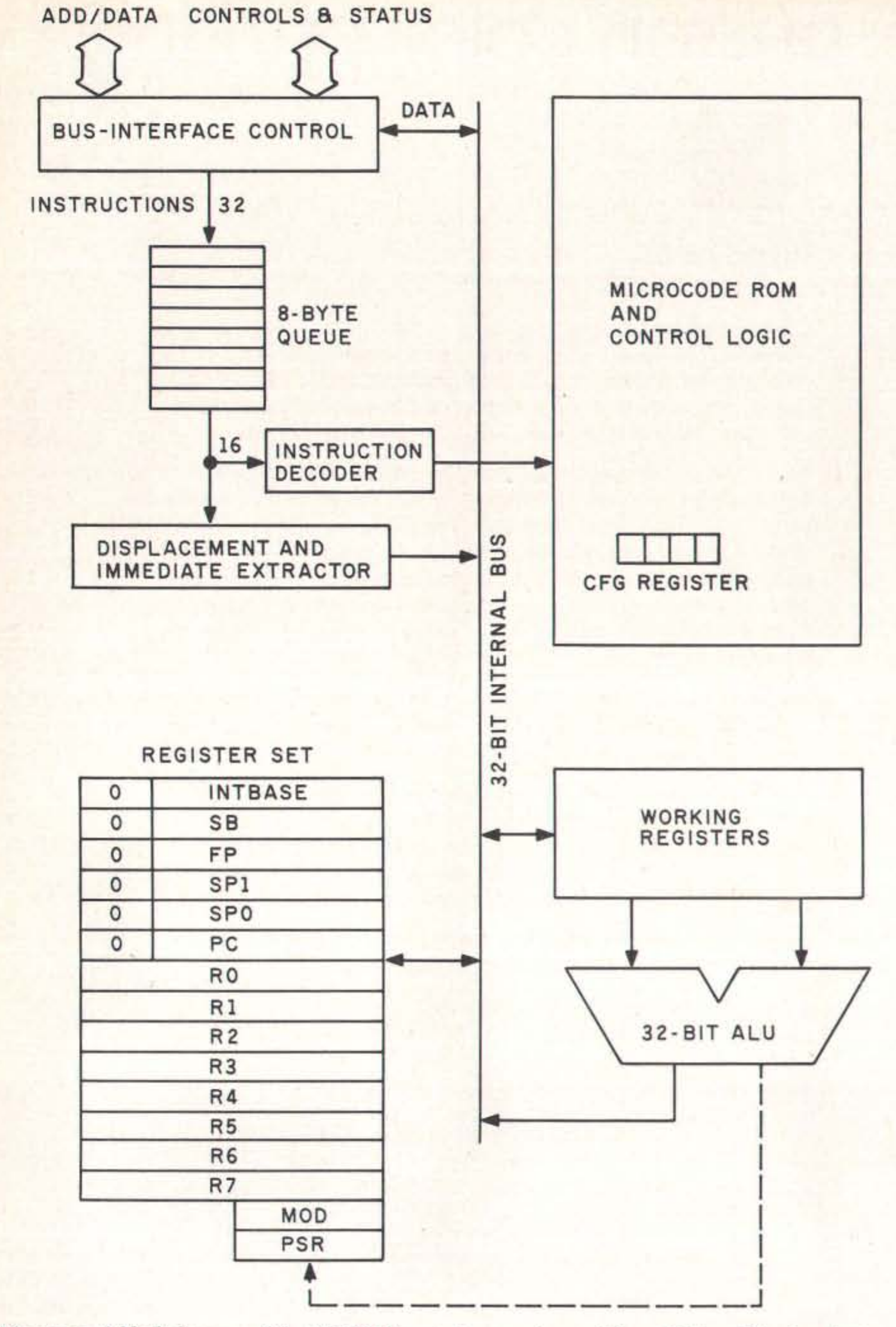


Figure 2: *A block diagram of the NS32032 central processing unit from National Semiconductor.*

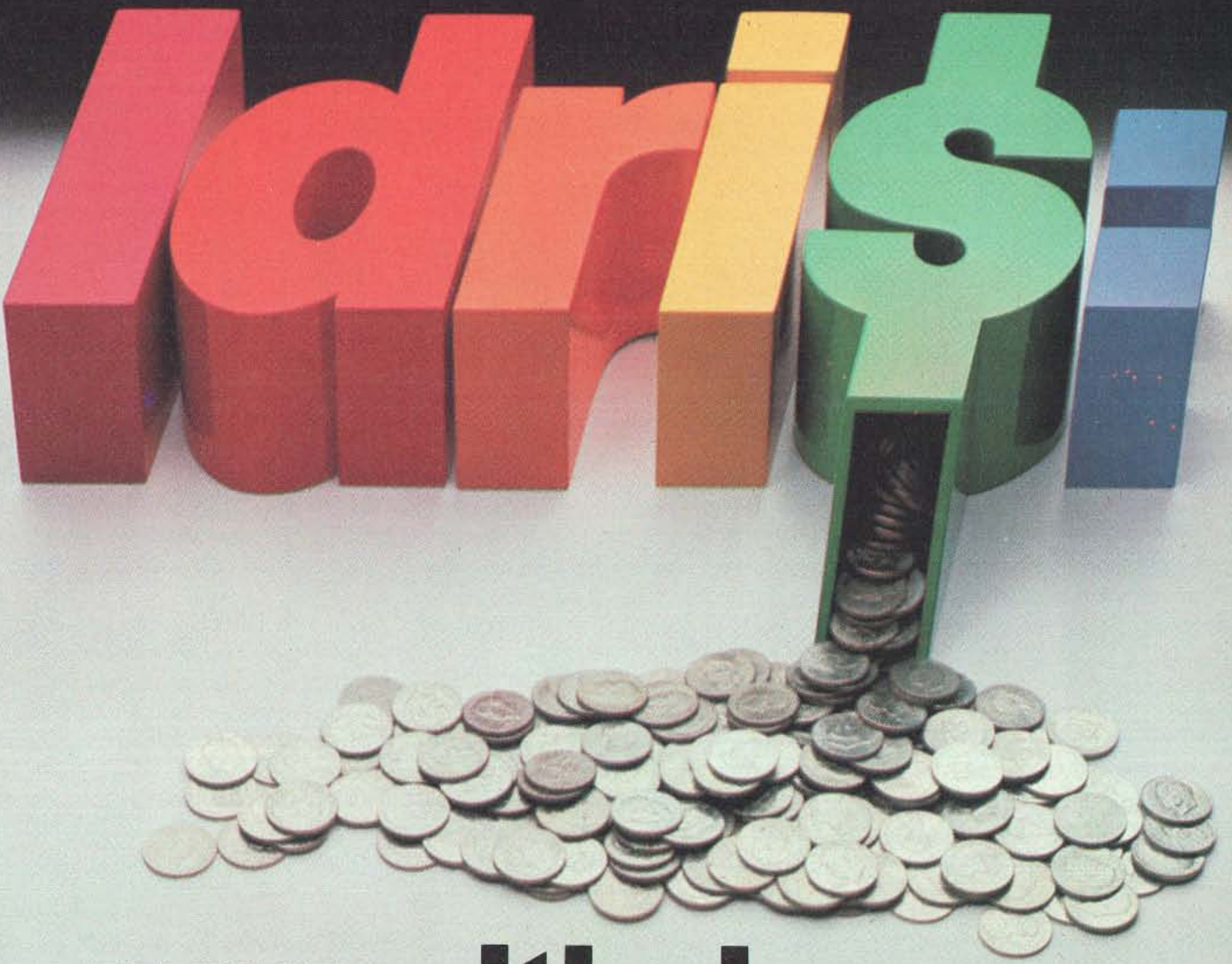
NS16082, and a floating-point unit, the NS16081. Floating-point and memory-management control instructions are integrated into the central processor and communicate with the support chips through a slave processor protocol. This arrangement enables transparent integration of the three chips into one.

Figure 2 is a block diagram of the NS32032 central processing unit. An important feature of this chip is the 8-byte instruction prefetch queue. This small FIFO (first-in/first-out) buffer lets the central processing unit make 32-bit aligned transfers from the instruction stream, even though NS32032 instructions vary in size and have no alignment restrictions. This 8-byte buffer provides another benefit, achieved in other central processors with a much more costly on-chip instruction cache. By letting instruction fetching proceed asynchronously from execution, instructions load as fast as necessary, up to the full bandwidth of the memory bus. Because the compactly encoded NS32032 instructions load faster than they execute even with external memory management, the central processing unit executes in-line code at full speed. In fact, in typical applications, the NS32032 central processing unit occupies less than 50 percent of the available bus bandwidth, making it suitable for complex systems containing multiple central processors, DMA transfers, and high-speed graphics.

The NS32032 is implemented in a 3.5-micron NMOS process and contains about 70,000 transistors. It runs at 10 MHz. A CMOS version and versions running at higher clock speeds are planned for 1984. The machine uses a three-stage pipeline for instruction execution: the first stage is the loader, which removes instructions from the queue; the second stage is the preprocessor, which decodes instructions; the final stage is the microcode-execution unit. Microcode executes at the rate of one microinstruction per clock cycle (100 nanoseconds).

The NCR NCR/32. This microprocessor chip set is quite different from all of the other microprocessors discussed in this article. It is designed to be externally microprogrammed to emulate other computers, principally medium-sized IBM mainframes like the System 370. The chip set consists of:

- the NCR 32-000 CPC, the central processing unit. It contains 40,000 transistors and is fabricated in a 3-micron silicide NMOS process. It runs with a 13.3-MHz clock, with internal machine cycles occupying two clock cycles (150 nanoseconds). The 16-bit microinstructions, read from a 128K-byte external storage unit, select 95-bit words from an internal ROM to control 179 operations, mostly register-to-register arithmetic and logical operations on 4-bit, 8-bit, 16-bit, 32-bit, and field data types. Microinstructions are executed in a three-stage pipeline (fetch, interpret, execute). Eight 16-bit jump registers support a rich set of conditional operations at the microcode level, and special set-up microinstructions facilitate IBM System 370 emulation.
- the NCR 32-010 ATC, the memory management unit. In addition to ad-



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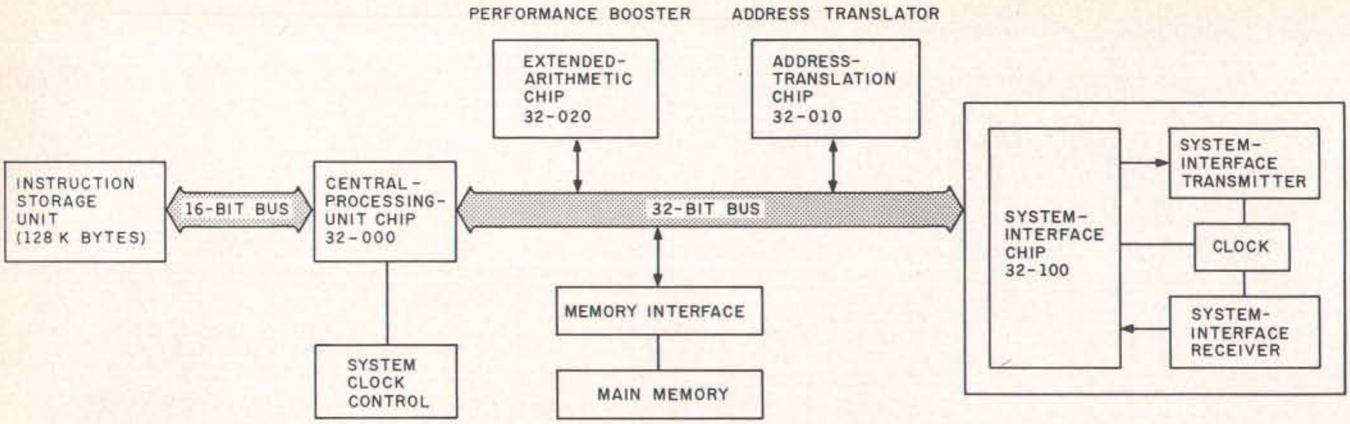
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Figure 3: *A configuration of the NCR/32 System.*

dress translation and access protection, this chip provides memory-refresh control, error-checking and correction (ECC) logic, a time-of-day register, an interval timeout interrupt, and an interrupt on writes to one specified virtual address. Sixteen translation registers support mapping of 32-bit or 24-bit virtual addresses into 24-bit physical addresses, using page sizes of 1K, 2K, or 4K bytes.

- the NCR 32-020 EAC, the "booster" chip for arithmetic operations. It supports IBM-compatible single- and double-precision binary and floating-point arithmetic, packed and unpacked decimal storage, and format conversions. A single-precision floating-point addition takes approximately 1.6 microseconds.
- the NCR 32-500 SIC, which interfaces the 24-megabyte/second processor memory bus to slower peripherals and to other systems.

The configuration of an NCR/32 system is shown in figure 3. No benchmark data has been published, but NCR estimates performance of the NCR/32 at approximately four times that of a 10-MHz 68000.

The Western Electric WE32000. This microprocessor was designed from the start to support Unix and C. Although a great deal has been published about the process technology, electrical design, emulation techniques, and testability of the WE32000, few details are available about its architecture. The basic chip set consists of a central processing unit and an MMU, each realized in 2.5-micron "domino" CMOS and running at 8 MHz. Versions meant to run at much higher speeds have been designed but are not officially acknowledged by Western Electric. The central processing unit contains 146,000 transistors, and the MMU contains 92,000. Figure 4 shows a block diagram of the central processing unit.

The WE32000 instruction set features a high degree of orthogonality of operation, addressing mode, and operand size selection. All binary arithmetic operations are available in two-address and three-address forms, and unary operations all have two-address forms. In general, the op code specifies the operand size, with all operands extended to 32 bits before operations are performed. When operands of different sizes are operated upon, an explicit type specification in an "expanded type" addressing mode overrides the operand size implicit in the op code.

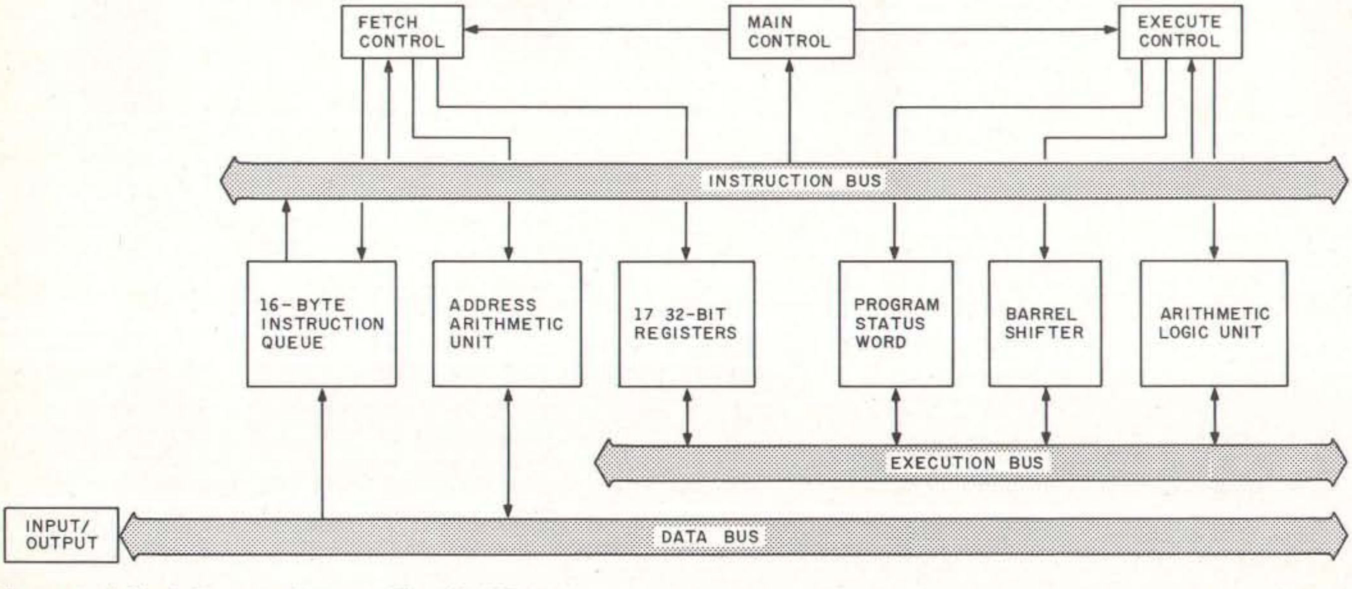

Figure 4: *A block diagram of Western Electric's WE32000.*

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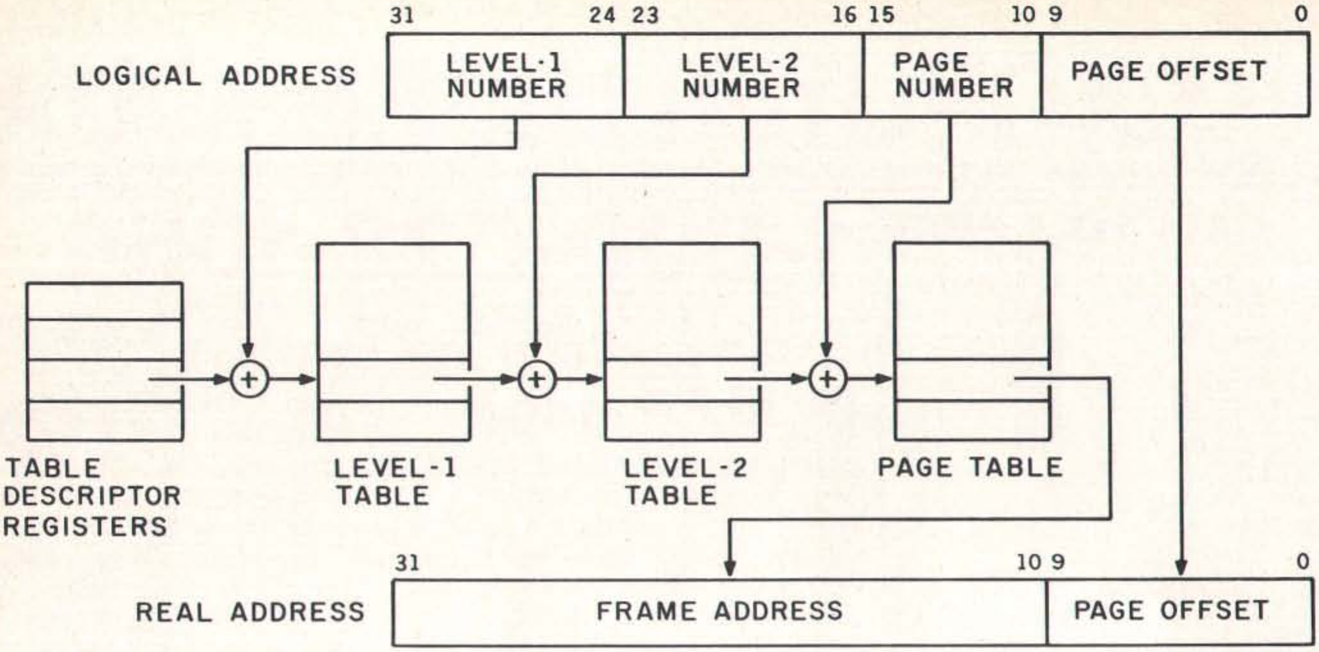

Figure 5: *The Z80000 address translation scheme.*

The WE32000 provides bit-field and string instructions. All strings terminate with a zero byte, as is standard for C programs. Floating-point instructions are also included in the instruction set, but these are intended to be executed by an external floating-point chip. Western Electric has not announced plans for such a chip.

Procedure linkage on the WE32000 is similar to that of the VAX. All sixteen 32-bit registers can be referred to in the machine's addressing modes. Seven of them, however, are given special functions; a program counter (PC), an interrupt stack pointer, a process control block pointer, a processor status word, a stack pointer (SP), a frame pointer (FP), and an argument pointer (AP). The PC, SP, FP, and AP play special roles in procedure linkage. In addition, the SAVE instruction, executed upon entry to a procedure, lets registers R3 through R8 be saved in a single instruction. Registers R0 through R2 are intended for passage of information between caller and callee, and they are accordingly not modified by the procedure-calling and return sequences.

The WE32000 supports multitasking operating systems like Unix. Without getting too detailed, here's the essence of multiple-task, or process, support. First, the machine supports four privilege levels and a "controlled transfer" mechanism (similar to the system call on machines with only User and Supervisor modes) for moving among them. A process, however, has only one execution stack, which makes the passing of arguments between levels quite painless. Furthermore, because the kernel is assumed to be in the address space of every process, sharing of buffers between the user and kernel routines makes copying unnecessary. Finally, the context of a process (central processor registers and address translation tables) is stored in process control blocks in memory, and special central processor instructions implement rapid switching between processes. This mechanism is also used for interrupts, which are treated like processes called unexpectedly.

The Zilog Z80000. This is the 32-bit member of the Z8000 family. An upward-compatible extension of the Z8000 architecture, it features dynamic bus sizing, sixteen 32-bit general registers, on-chip data and instruction cache (256 bytes), and on-chip memory management using memory-based tables with an automatically managed 16-entry TLB. The address-mapping scheme enables either linear addressing or several upward-compatible extensions of Z8000 segmented addressing. Demand-paged virtual memory is supported with 1K-byte page size. Figure 5 shows the address translation method.

The machine is implemented in a 2.0-micron NMOS technology designed to enable speeds up to 25 MHz. The initial version runs at 10 MHz. Internal machine cycles take two clock cycles. Zilog estimates that with a high-performance memory configuration, typical programs will execute at the rate of one instruction every 6.8 clock cycles, resulting in an execution rate of 1.47 MIPS. Both bus size and bus timing are dynamically controllable, with accesses adhering to the Z-BUS protocols used by Zilog's Z8000 peripheral family. Nibble-mode (burst) transfers support prefetching of instructions into the cache. Like the Z8000, the Z80000 is designed for use with an external floating-point chip, which Zilog plans to make available in 1985.

Which Is the Best One?

Of course, I won't touch that question with a 10-foot pole, but further discussion of the 32-bit chips may be useful. The first interesting point is that the microprocessors fall into groups. For example, the WE32000 and the NS32032 show many similarities, and both are close to the VAX. Similarly, the MC68020 and the

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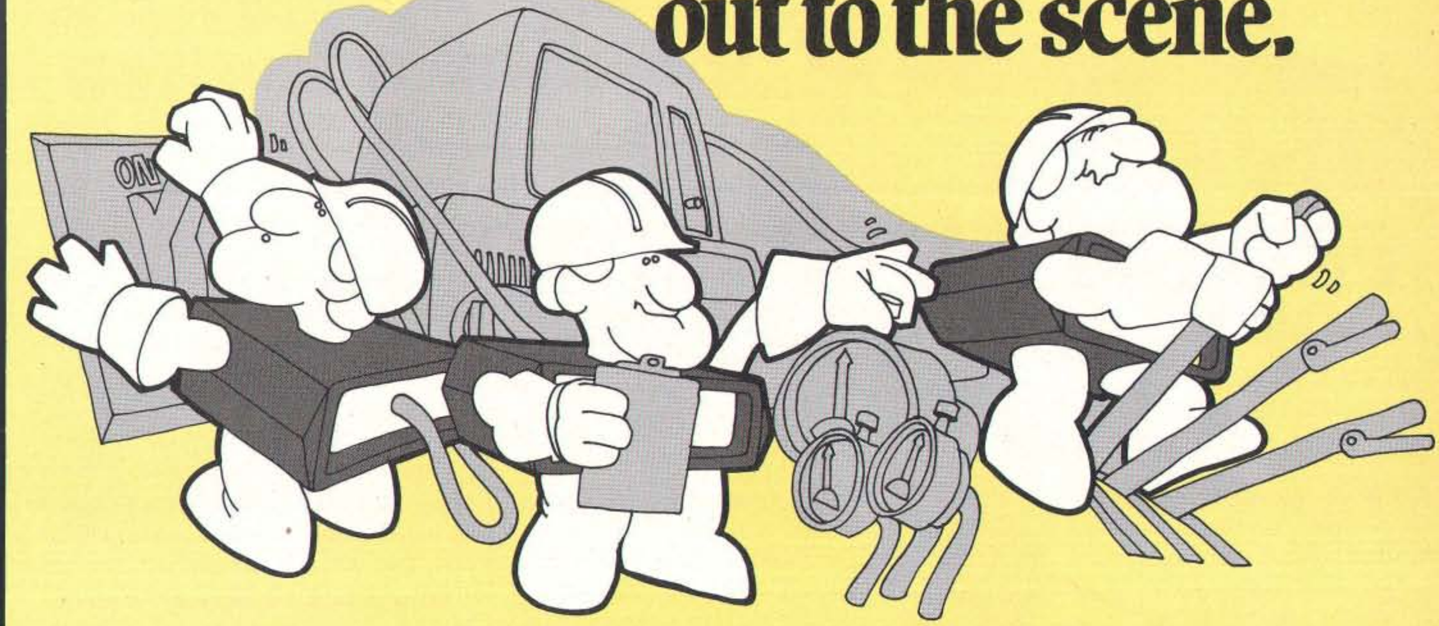

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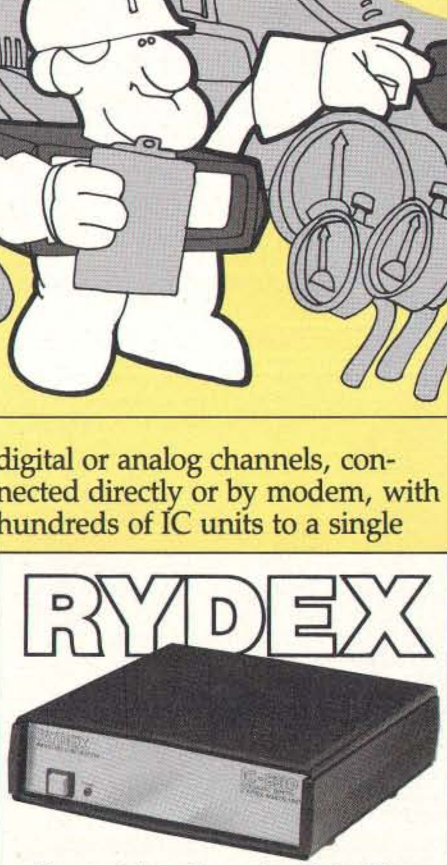

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Z80000 are closely parallel, both being upward-compatible extensions of 16-bit central processing units designed in the PDP-11 tradition. The HP Focus, with its architectural heritage from the Burroughs line, is unlike the other chips discussed here. It's too early to know where to place the iAPX386, but it's probably closest to the Z80000 and the MC68020. The NCR/32 family, with its theme of emulation through external microcode, is related to the RISC machines, as is the Inmos Transputer. These comparisons are meant only as food for thought—don't make too much of them.

Floating-point support is an important issue. The overwhelming trend is toward execution of IEEE-format operations using a coprocessor chip. Only the HP Focus does on-chip floating-point operations. NCR/32 follows the IBM style of floating-point math, different from the IEEE proposed standard. The VAX also uses its own formats, some similar to IEEE formats.

Demand-paged virtual memory seems to be a universally accepted choice, using a separate memory-management circuit. Only Zilog and Intel use on-chip memory management; Zilog's technique evolves from the separate-chip approach, and Intel upgrades the rudimentary on-chip memory management of the 8086 and 286.

Execution speed is a tricky area, and I've been involved in enough benchmark studies to know better than to shoot from the hip here. What's needed, once all of these 32-bit microprocessors are real, is a comprehensive comparison study like the one in *EDN* magazine's issue of September 16, 1981. There is probably less than a factor of 4 between the fastest and the slowest of these microprocessors. All of the 32-bit chips are a cut above the best 16-bit microprocessors.■

Richard Mateosian (2919 Forest Ave., Berkeley, CA 94705) is the technical marketing manager for the NS16000 family at National Semiconductor. He is the author of Programming the Z8000, *published by Sybex in 1980, and* Inside BASIC Games, *Sybex, 1981.*

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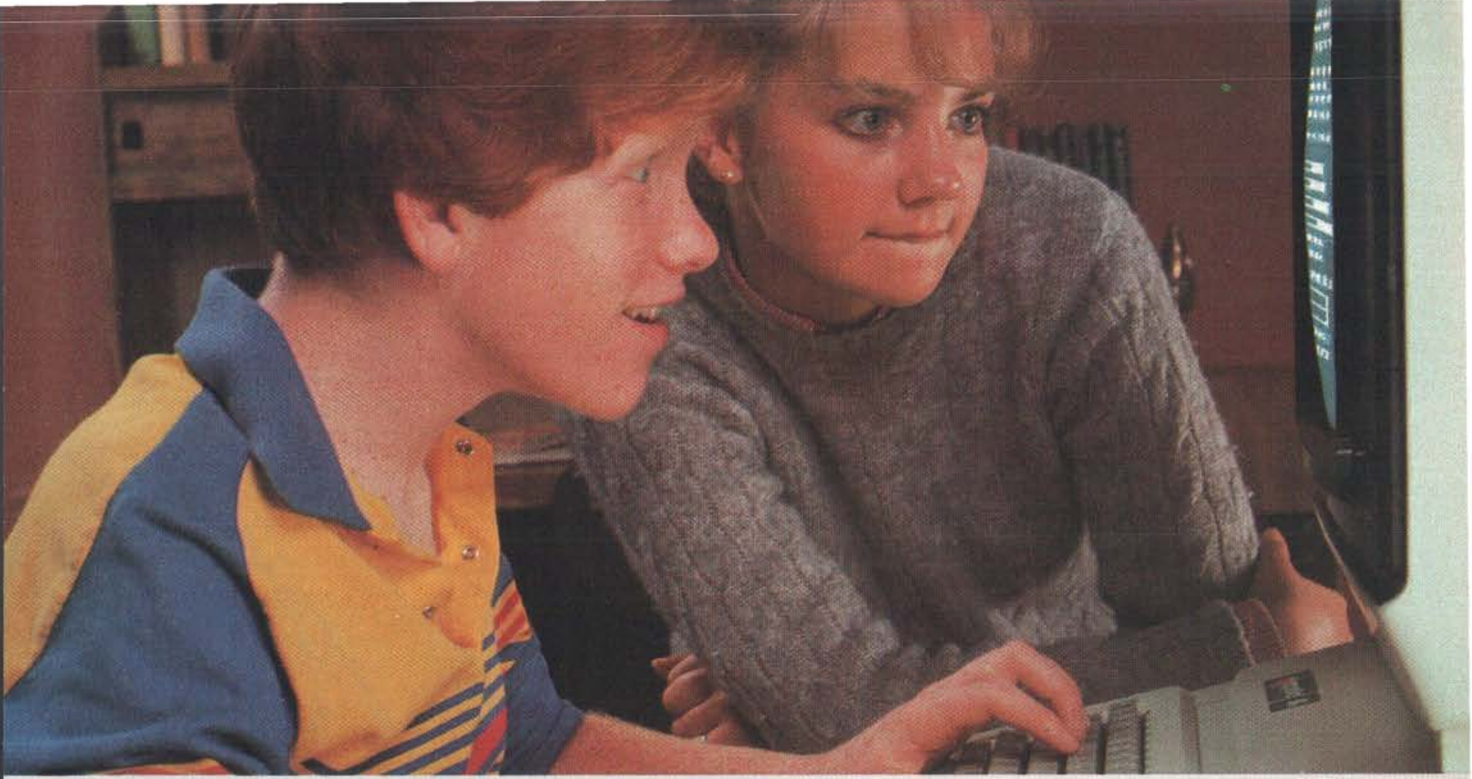

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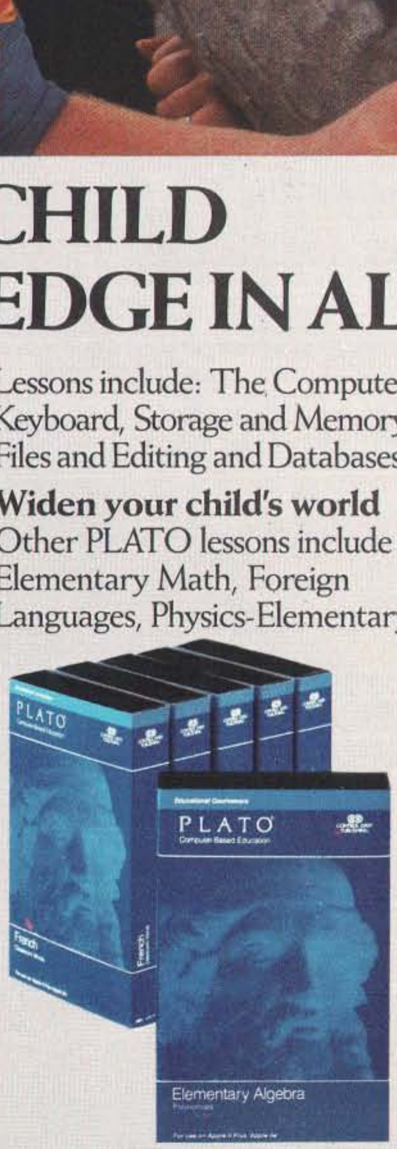

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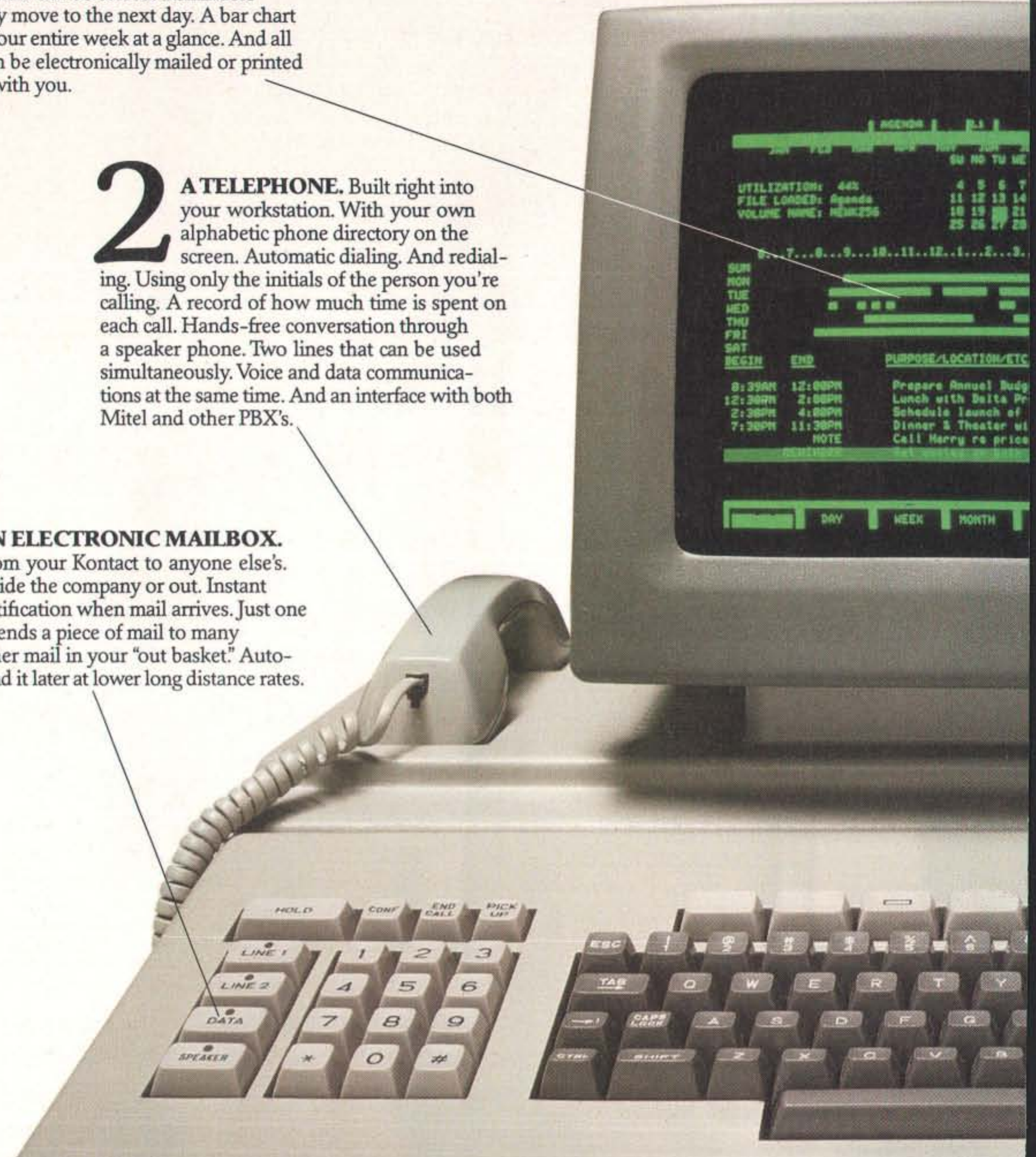

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Memory Cards: A New Concept in Personal Computing

These miniature microcomputers could become the most popular portables

by Mark Mills

One fascinating new microcomputer has neither keyboard nor power supply, and chances are that you'll soon carry one in your wallet. This type of memory card (also called a "smart card" or "chip card") is the same size and shape as a credit card and contains an embedded microcomputer. Currently being test-marketed in the United States and Europe, memory cards are designed to record and play back information in a secure fashion.

Another type of memory card doesn't have an embedded microcomputer but instead has a special coating on which information can be encoded. Yet another type is not card-shaped but resembles a fat plastic key with a nonvolatile semiconductor memory embedded in it (see photo 1). Throughout the rest of this article, "memory card" will be used to indicate all three types of implementations.

Presently, the primary application for memory cards is in the area of

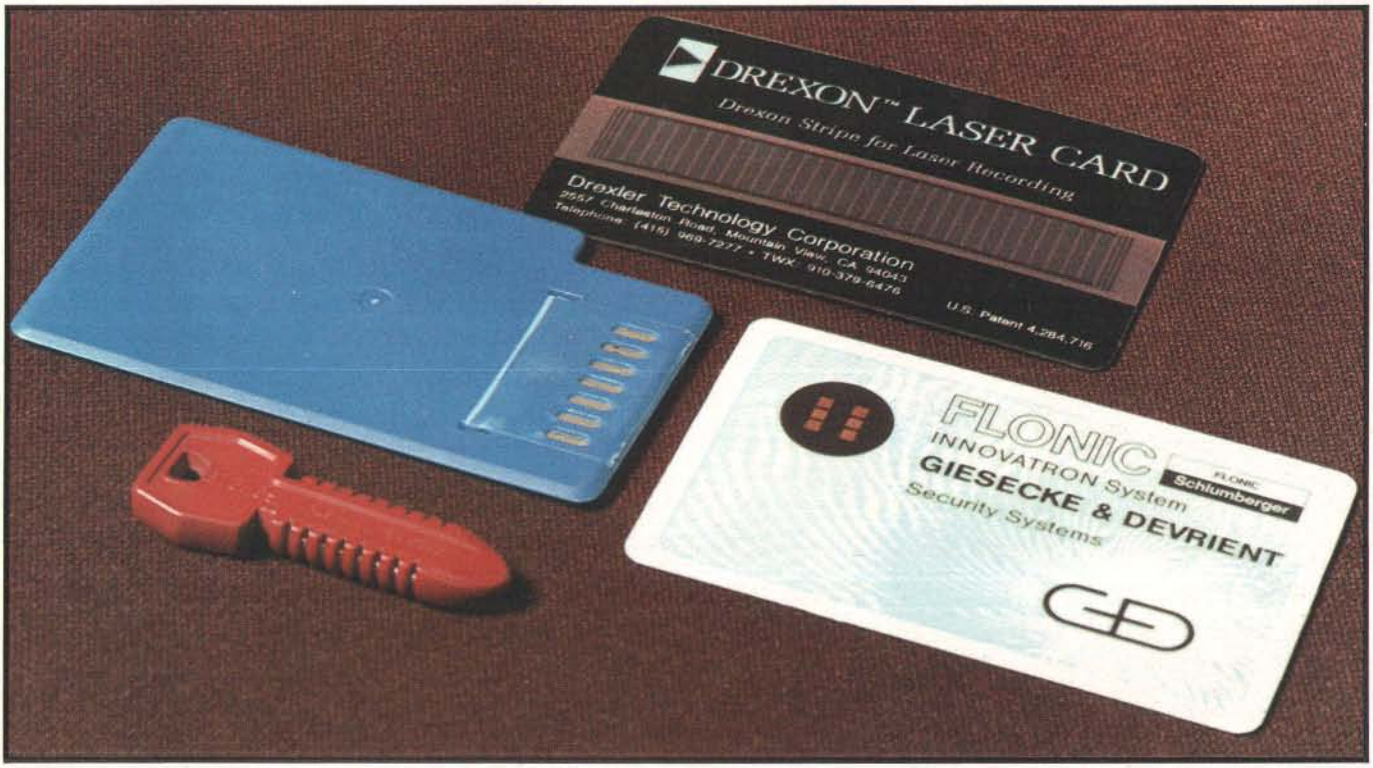
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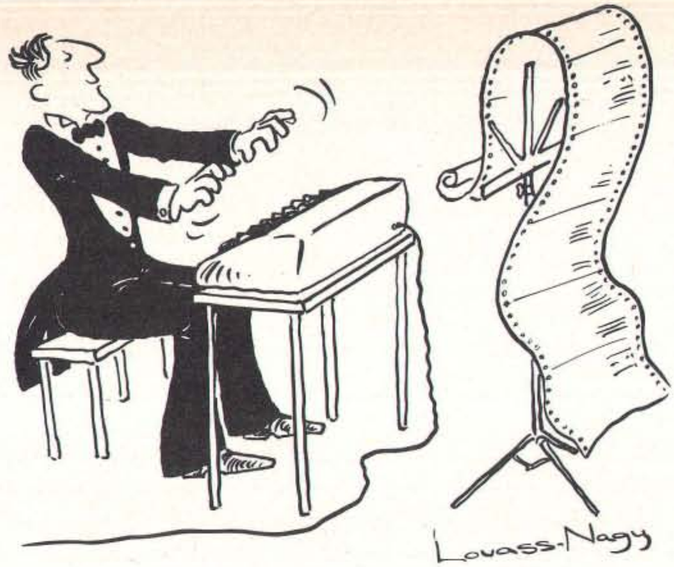
Photo 1: *Four memory cards incorporated into different carrier packages. The bottom three cards are active devices, containing embedded microcomputers. Note the metal contact points on their surfaces (on the "key," the contacts are between the ridges). The top card is a passive device that uses an optical stripe for laser recording and playback.*



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electronic funds transfer (EFT). France has several trial programs underway to demonstrate "electronic money" using memory cards. For example, videotex users may purchase goods and services in their homes using memory cards. In Italy, a semiconductor firm is manufacturing prototype memory cards for pay telephones. You buy a memory card with a "preloaded" amount of money, and, with each phone call, an amount is deducted from the memory card's balance. When the amount reaches zero, the card is discarded. (See the text box below.)

Other proposed uses for memory cards include personal identification (using physiological traits), driver's licenses, ski-lift tickets, passports, data recorders for pacemakers, hotel door keys, input devices for computer-controlled equipment, and extended memory for computers.

Memory-Card Technology

Memory cards are implemented using three types of technologies: monochip memory cards, multichip memory cards, and optical-stripe memory cards. A monochip memory card has only one integrated circuit (IC), which includes a single-chip computer that holds a maximum of about 4000 bits of information in programmable read-only memory (PROM). This PROM is used to record and play back the "transactions" of the memory card. A PROM-based card could be considered disposable because once its memory is full, the memory cannot record new transactions. To overcome this drawback, manufacturers are now investigating the use of electrically erasable read-only memory (EEROM). Although this technology eliminates the "use until full" problem, it may increase problems related to card security and integrity.

	Bits	Characters (bytes)	Reusable memory
Optical stripe	16M	2M	no
PROM	128K	16K	no
EEROM	64K	8K	yes
EPROM	128K	16K	no
Magnetic stripe	1.7K	212	yes

Table 1: *A comparison of the storage capacities of all the types of memory cards.*

A memory card with more than one IC is called a multichip card. The multichip card is more versatile because it has a memory capacity of approximately 16,000 bits of information and does not require the high degree of IC customization the monochip card does. With the improvement of packaging techniques and IC technology, multichip cards with large memory capacity will become commonplace.

An optical-stripe memory card has a special surface similar to the coating on a videodisk rather than embedded integrated circuitry. A single optical stripe the size of the magnetic stripe on a credit card can hold 16 million bits of information; a similar size magnetic stripe on a typical credit card holds only about 1700 bits of information. Table 1 provides a comparison of storage densities for memory cards.

A memory card that incorporates a microcomputer is known as an *active* memory card. This type of card has some degree of internal intelligence that enables it to make decisions about its interactions with the outside world. These decisions can range from the security of its stored information to initiating the proper sequence of steps required to enable a transaction to be processed. Regardless of the nature of the interaction, the active memory card

It's in the Cards

Approximately five years ago, the French Telecomms Administration initiated a cohesive research and development program from which memory cards and other related products have evolved. Memory cards were originally designed to exploit integrated-circuit technology in a credit-card-shaped package for electronic funds transfer (EFT). This technology is being developed to replace check writing as a method of payment. With the astronomical number of checks written annually, it is not hard to see why a less labor-intensive method of payment is being developed. Presently, several test sites in the United States and France are studying this concept in conjunction with videotex systems.

Memory cards are also being evaluated in lieu of money for pay telephones. Advantages to using telephone memory cards include no coins to collect from coin boxes, less vandalism (because no money is kept in the telephone itself), and instant collection of payment for services. Current problems these test markets must resolve are the matter of contact reliability between the memory card and the transaction terminal and the integrity of memory-card security systems. These issues, as well as that of public acceptance, must be resolved before a full-scale memory-card application for EFT can be implemented. It will probably be several years before memory cards are widely in use.

At present, there are no in-place systems for memory cards in the U.S. However, the U.S. Department of Agriculture plans to soon choose a contractor for a demonstration of a memory-card system that could replace the paper coupons in the food-stamp program. The cards would be issued with the equivalent amount of money in memory, thereby eliminating the paper, paperwork, printing, and handling of stamps for the approximately 8 million households in the food-stamp program.

Another area in which memory cards are being used is to augment or replace "dog tags" currently used in the military. The memory card could not only keep the traditional name, rank, and serial number data but also store a soldier's training history, medical records, and so on.

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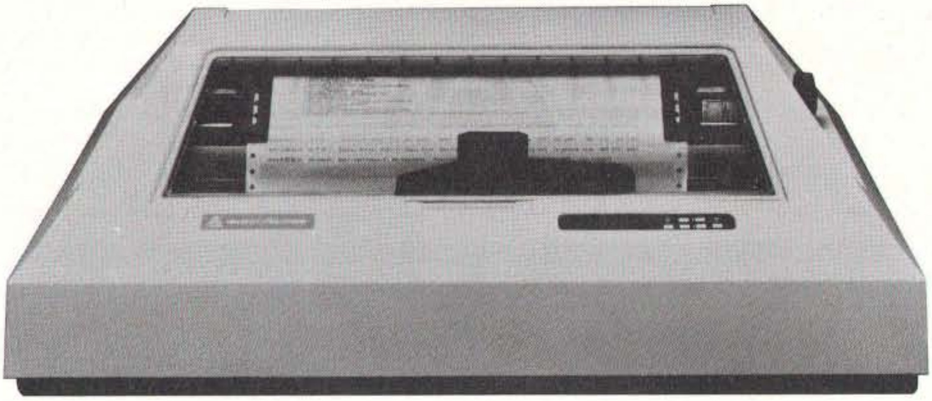

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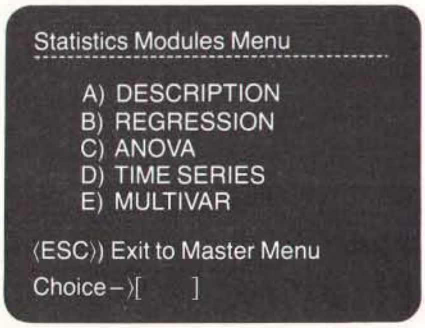

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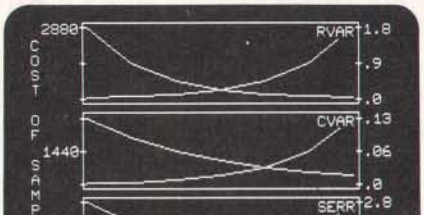

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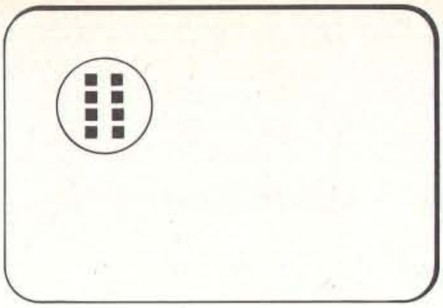

Figure 1: *A typical arrangement of the contact points of an active memory card. Relatively few (six to eight) contacts are needed because the data is transmitted serially. See the Flonic security card in photo 1.*

plays a direct part in its own destiny.

On the other hand, a *passive* memory card (e.g., an optical-stripe card) has no active intelligence and depends entirely on the outside world for interaction. A passive card is not unprotected, however, because this type of device can dedicate a portion of its larger memory-storage capacity to identification data of its owner. For instance, its card reader might require a match with a digitized picture, fingerprint, or voiceprint to confirm identification; an ample amount of storage capacity would be left over for transactions. Data-encryption schemes further increase the security of passive cards.

The design of the card reader or transaction terminal depends on whether the memory card is active or passive. In the case of an active card, a transaction terminal would need only I/O (input/output) devices and a power supply because the memory card already contains a microcomputer (see photo 2).

By contrast, the optical-stripe card requires some type of sophisticated laser-based data-transfer system to decipher the small dots encoded on the card's surface.

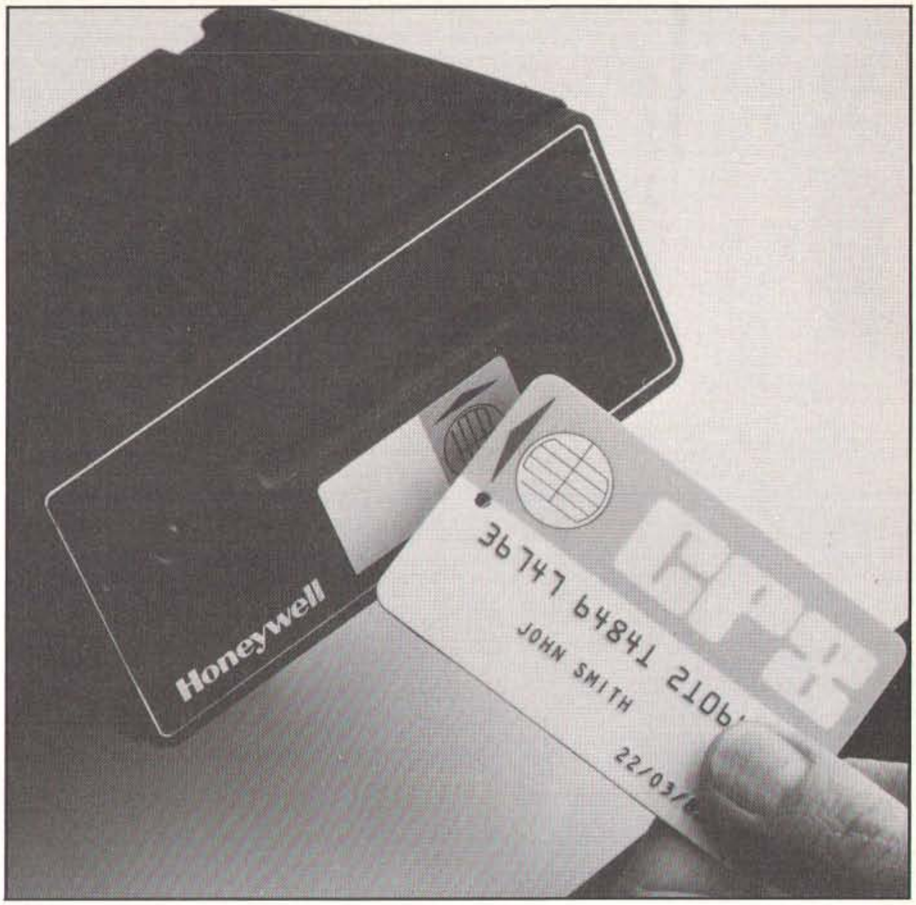

Photo 2: *A transaction terminal (or card reader) for an active memory card.*

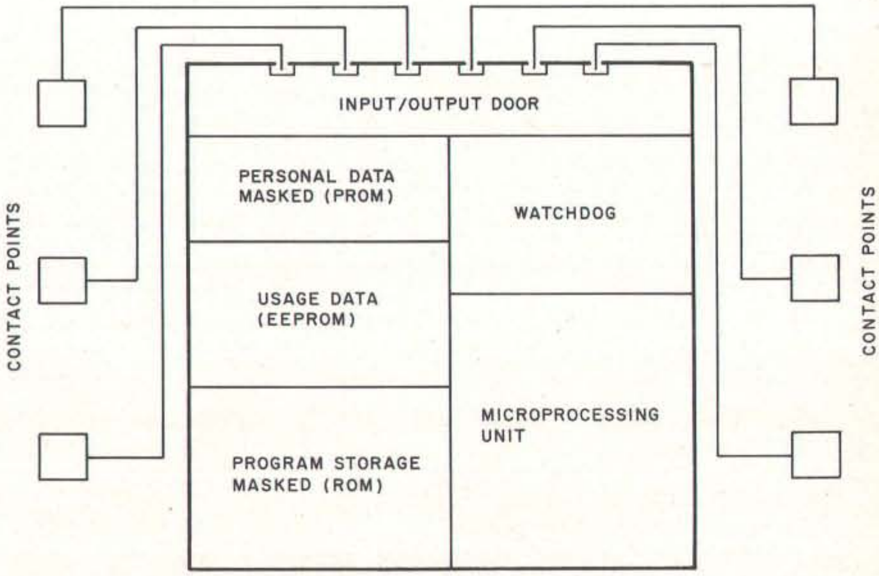

Figure 2: *The system architecture of a monochip-based memory card.*

Memory-Card Architecture

The active monochip memory-card architecture typically contains a single microcomputer embedded in a package the size and shape of a credit card. The microcomputer is connected to the outside world via contact points on the memory card's surface. Very few contact points are necessary because only power and data pass between the memory card and the transaction terminal. Figure 1 shows the basic physical layout of a monochip memory card. Figure 2 shows the general architecture of a monochip memory card.

The architecture of multichip memory cards is basically similar to that of monochip cards except that large memory capacities are possible and each subsystem can be a separate IC. Figure 3 shows a multichip memory and architecture.

Data is typically transferred by an

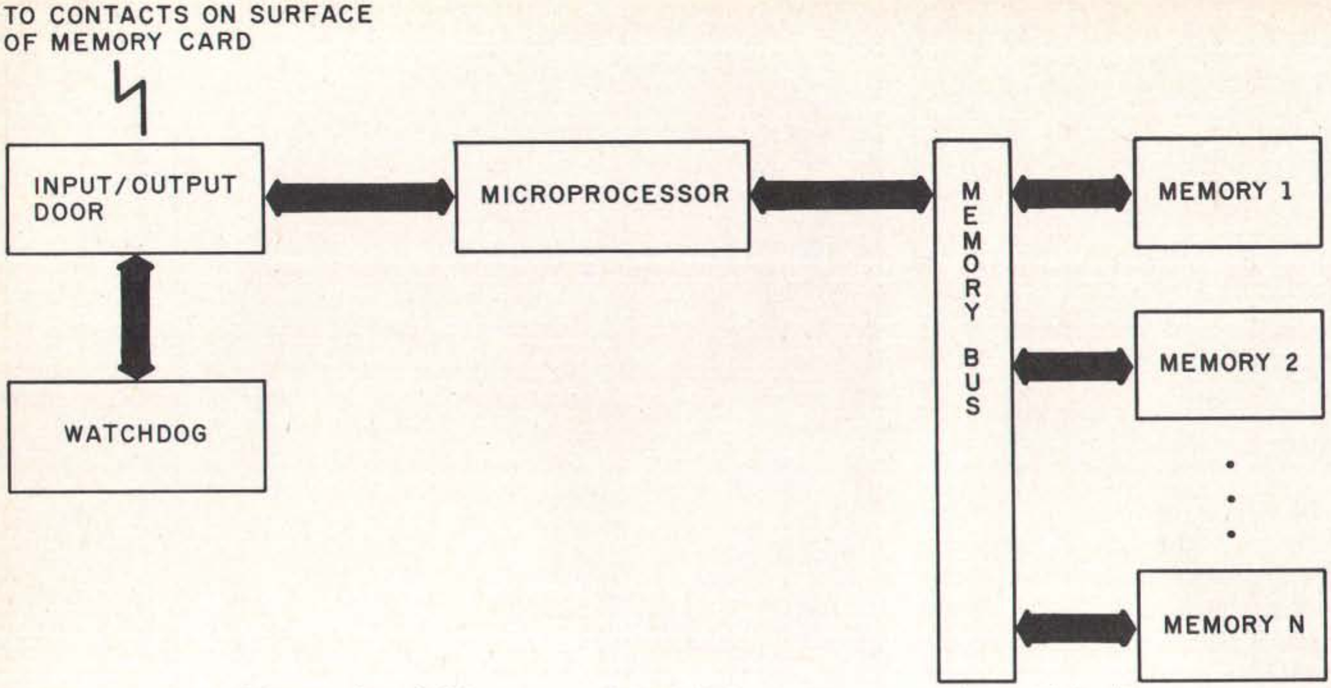

Figure 3: *The system architecture of a multichip memory card. Each block represents a separate integrated circuit.*

I/O door. This *doorway* is similar to a universal asynchronous receiver/transmitter (UART) and is monitored by a *watchdog*—the "security officer" of the memory card. The function of the watchdog is to make certain that the I/O transactions are valid. For example, successive attempts to initiate a transaction using improper access codes would cause the watchdog to close the I/O door permanently, rendering the card useless for future transactions.

The memory section of monochip and multichip cards is a combination of four types of memory: factory-programmed ROM (read-only memory), RAM (random-access read/write memory) for temporary data storage, and EEROM or PROM, in which transactions are stored.

The architecture of the optical-stripe memory card is relatively straightforward. A special material, used in the manufacture of videodisks, is placed on the back of a standard credit-card-shaped carrier. At a glance, the average person may not even notice the difference between a regular magnetic-stripe credit card and an optical-stripe memory card. The special stripe is actually composed of four layers: a protective coating, a reflective layer, a nonreflective layer, and a substrate layer (see figure 4). Data is encoded on its surface by burning small holes approximately 5 microns in diameter into the reflective layer. A low-power laser is used to "burn" the data onto the stripe and to read it back. By scanning the optical stripe with the laser, a bit stream of data is produced. Figure 5 shows what happens when a laser scans the optical stripe.

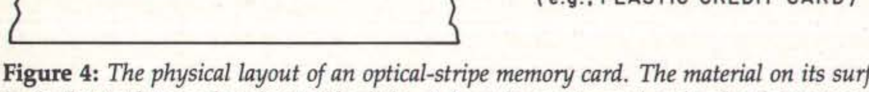

Figure 4: *The physical layout of an optical-stripe memory card. The material on its surface is similar to that used on laser videodisks. A laser is used to read and write the transaction information.*

Memory-Card Terminals

Because transaction terminals are necessary for a complete memory-card system, a brief discussion will help to understand how the whole system works.

A transaction terminal is a communication station used to transfer information into and out of memory cards. Basically, transaction terminals consist of two parts: a display with an attached keypad and a memory-card interface. The display and keypad could be a standard serial terminal. The memory-card interface "customizes" the transaction terminal for a particular type of memory card. There are two types of interfaces: one for optical-stripe memory cards and one for monochip and multichip memory cards.

The terminal interface for an optical-stripe memory card contains a computer-controlled laser data-transfer scanner. This scanner knows how to interpret or write dots on the memory card into meaningful data. Because this type of adapter needs a computer and a laser to read the memory card, it would be more expensive to manufacture than the

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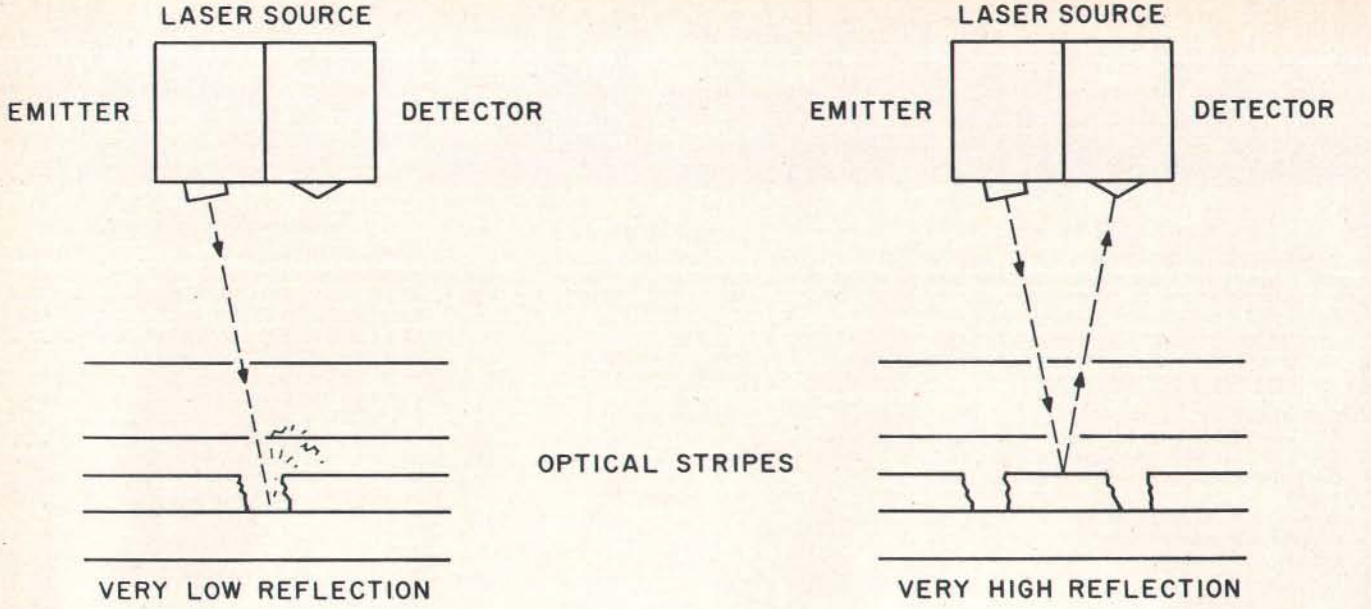

Figure 5: *The process of reading data encoded on an optical stripe. On the left, the laser beam encounters a hole written in the reflective layer so no light reaches the detector. On the right, the beam is reflected to the detector from an undisturbed section of the reflective layer.*

interface for monochip and multichip memory cards.

A terminal interface for monochip and multichip memory cards is no more than a small housing with a mechanical device to connect the memory card to the terminal's contact points. These points provide power to the memory card and serial communications capability to the display and keypad. Information can be exchanged as long as the transaction terminal adapter is connected to the memory card.

Memory-Card Packaging

By definition, memory cards must be small enough to be carried conveniently. The most common package for memory cards resembles a credit card. However, there are possible drawbacks to incorporating electronic circuitry within a 30/1000-inch thickness of plastic. Manufacturing the plastic card liberates corrosive gases that can affect integrated circuits. Furthermore, producing such a package is difficult using conventional semiconductor fabrication techniques.

Fortunately, a process known as tape-automated bonding (TAB) solves most of these problems. It's currently used to manufacture such items as electronic watches and very thin pocket calculators. TAB originated in the U.S. in 1969 and uses a flexible printed-circuit carrier tape, which looks like 35mm movie film, to which an IC is bonded and tested (see photo 3).

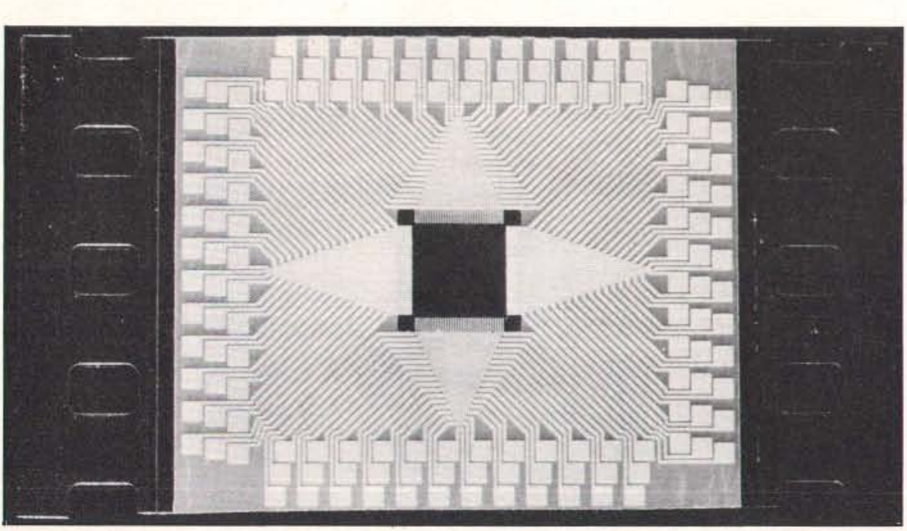

Photo 3: *An integrated circuit bonded to a carrier tape or TAB (tape-automated bonding). This process is used to fabricate thin electronic devices such as calculators and memory cards.*

Memory-Card System Costs

Card costs will depend on two factors: the technology used and the volume of production. In high volume, optical-stripe cards should cost about 50¢ each, monochip cards about $4.50 each, and multichip cards about $8 each. In low-volume production, these prices would be significantly higher (see table 2).

The cost of the transaction terminal must be considered in addition to the cost of the distribution and manufacture of the memory card. A simple transaction terminal for active memory cards may be priced as low as $250, whereas a transaction terminal for passive memory cards will cost at least $1500. These costs are significant because anyone wishing to use a memory card will need a reading device.

Security

It stands to reason that the more you need to protect the information on your memory card, the more valuable (or private) the information is.

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Type of memory card	Low volume	High volume	Memory capacity in characters (bytes)	Cost per character
Monochip	$16.00	$4.50	4K	3.9¢
Multichip	50.00	8.00	16K	3.05¢
Optical stripe	4.00	.50	2M	.0002¢
Magnetic stripe	3.00	.60	212	13.6¢
Optical/magnetic dual stripe	8.00	1.10	2M	.0004¢

Table 2: *A comparison of card costs at low- and high-volume production, and the cost per character stored for the various memory-card technologies.*

For instance, a memory card that contains information regarding your bank accounts would warrant more protection than a memory card used as a ski-lift token. Security of information is a matter of personal judgment depending on how "private" that information is to the individual "owning" it. Most card systems in use today (e.g., paper and magnetic-stripe cards) offer little or no privacy, whereas memory cards would offer several avenues for privacy and for protection of sensitive information.

Memory-card security is achieved by limiting the number of people who have access to the information stored on the card. Furthermore, granting someone access to information on the memory card should not mean he has permission to update, modify, or add information to the memory card. To protect information on the card, data encryption is used. The "key" to the code is jointly held by the card and the owner. However, just knowing the key should not constitute ownership; positive identification of the rightful owner is undoubtedly a requirement for a secure memory-card system. Finally, the memory card must keep a list of people who attempt to query or change information on the card.

Personal identification is possible using any of four different methods. Identification based on possession of an object (a card, for example) is not a positive means of identification because an object might be lost or stolen. Identification based on what a person knows (number or password) is not much better because it, too, can be lost or stolen. This method is currently employed by automatic tellers using magnetic-stripe cards. An automatic-teller card can be used by anyone if he knows the personal identification number that goes with the card. Both of these methods are easy to implement and inexpensive to produce.

The next two methods provide a much better means of positive identification. The first is based on some unchangeable biological feature, such as a fingerprint, voiceprint, or electrocardiogram pattern, that would provide virtually perfect identification. Its largest drawback is the expense of implementing the devices. The second method involves a learned trait or habit; the sound of a person's footsteps or a signature are distinctive learned traits. Learned traits are unique enough to be *almost* forge-proof and have the additional advantage of being generally inexpensive to measure. With these positive-identification techniques you can audit all accesses and attempted accesses to a memory card and identify those who made the requests.

Positive identification of the rightful owner is required for a secure memory-card system.

Memory cards suffer from the same type of external threats as do credit cards—illegal use of a valid card, modification of a valid card, and production of counterfeit cards. These three threats are compared for both memory cards and current magnetic-stripe credit cards in tables 3a and 3b. Although the probability of misuse and potential loss is comparable, the countermeasures available to protect memory cards make them preferable to magnetic-stripe cards.

Proponents of the technology are claiming that the memory card is unconditionally secure, but there is no solid evidence to support this claim. Experts in the field of security, cryptography, and microelectronics doubt these claims because of the rapid increase of computer crime in the past few years. Memory-card systems are more secure than the current magnetic-stripe technology, but their level of security in field-usable systems has yet to be determined. Currently there are field tests underway in the United States and in France that may prove to some degree the security of memory cards. However, the ultimate test of memory-card systems comes when they have been released on a very large scale. None of the existing field tests will be able to answer the question of security absolutely.

The Human Factor

The importance of human factors in computer applications is receiving increased attention, which is well deserved because most computer systems have not been designed with the user in mind. They have been designed instead from the standpoint of ease of implementation for the design engineers. Because memory cards are small portable computing devices, it is important that the proper human factors be considered in order to ensure the acceptance of memory cards in particular applications.

Nearly all the applications of memory cards involve financial institutions, which are moving over from standard credit cards. Their greatest

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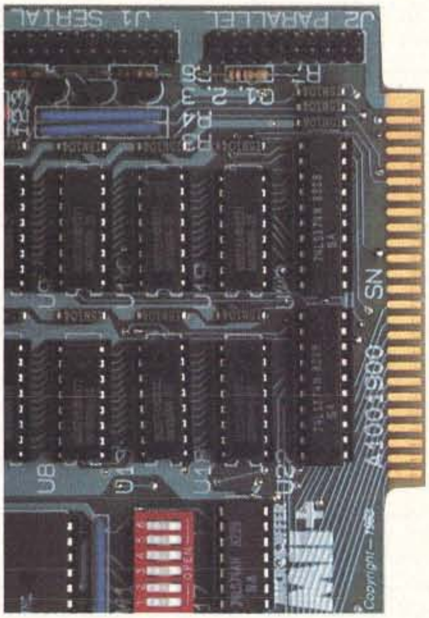

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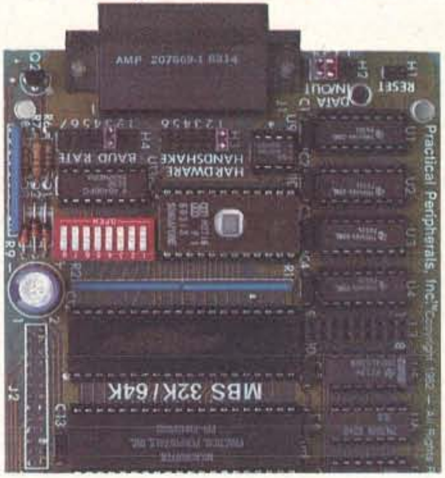

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(3a)

	Probability	Potential loss	Countermeasures	Skill level required
Illegal use of a valid card	high	moderate	moderate to poor	none
Modification of a valid card	moderate to high	serious	poor	medium
Production of counterfeit cards	high	enormous	poor to none	medium to low

(3b)

	Probability	Potential loss	Countermeasures	Skill level required
Illegal use of a valid card	high	moderate	good	low
Modification of a valid card	medium to low	serious	moderate to poor	high
Production of counterfeit cards	low	enormous	poor to none	high

Table 3: *Probable abuses of a magnetic-stripe card (3a) compared with the same factors for a memory card (3b).*

motivation for shifting to memory cards is to minimize fraud, theft, and misuse of credit cards.

Conventional credit cards have several advantages that have put them into widespread use today. They are easy to use, they don't require any special knowledge by the user, and they are cheap to manufacture (and therefore are generally provided for free). Their biggest fault is that they are very difficult to track if stolen. Another major disadvantage to credit cards is that they are easily counterfeited. Memory cards, on the other hand, can provide all of the advantageous features of a credit card while reducing, or eliminating, these disadvantages. The memory card could also provide a unified method of interaction with a financial institution, such as a bank; the memory card could serve as a credit card, a savings passbook, a checkbook, and an automatic-teller access card all in one. Other information could be carried as well: information on outstanding retirement accounts, auto loans, and savings bonds.

In order for this type of memory card to be readily accepted by new users, the card and the system must be as functional as the system they replace and should offer additional features (e.g., updated interest reporting for passbook savings accounts).

The memory card itself must have certain physical characteristics in order to be acceptable to a large group of users. It must be small, lightweight, and durable. Also, it should utilize a surface or shape that would let you identify the front, back, right, and left side of the card so it could be used in poor light or by a person who is visually impaired.

Memory cards can provide all of the advantages of a credit card, while reducing or eliminating the disadvantages.

Attention should be paid to the user's access to information within the memory card. This would require a small, portable terminal analogous to the calculators carried in some checkbook cases. A similar read-only device for active memory cards could be made by modifying such a calculator.

Nonfinancial Applications

Two examples of nonfinancial applications are memory-card software packages and memory cards used for on-board diagnostics of a personal computer.

Like any other machine, personal computers can need repair. Unlike other machines, computers cleverly disguise their problems, making them difficult to troubleshoot and repair. It would be beneficial to have an on-board "tattletale" memory card that could monitor the computer's operation so as to enable rapid detection and correction of problems. This device could keep track of such things as memory faults, bus errors, power-line surges, system glitches, and air temperature and relative humidity inside the computer chassis. The memory card might also perform a type of logic-analyzer function.

A diagnostic card could decrease maintenance costs because it could periodically be removed from the personal computer and its information displayed to determine the number of memory faults that had occurred, or the number of times the critical temperature was reached inside the chassis, thus signaling the necessity of maintenance. Therefore, memory cards for on-board diagnostics could decrease the life cycle costs because repairs would be easier to isolate and fix. Only the memory card would have to be taken to the appropriate service department for playback and inspection to diagnose the problem. This could save the owner of a personal computer a great deal of time, effort, and money.

Figure 6 shows a memory card used as a diagnostician. The "panic" button could be activated by the user if a potential problem is suspected. The button would alert the memory card to a situation in which an error may occur. The memory card could

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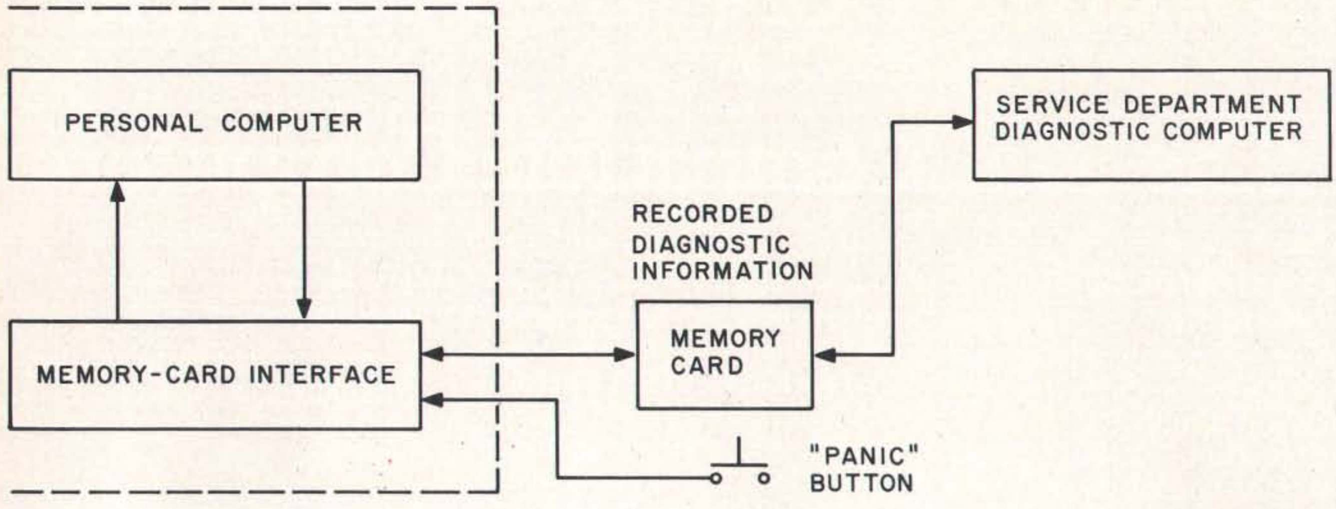
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RECORDED DIAGNOSTIC INFORMATION
MEMORY CARD
SERVICE DEPARTMENT DIAGNOSTIC COMPUTER
"PANIC" BUTTON

Figure 6: *A block diagram of an active memory card used as an on-board diagnostics device within a microcomputer.*

then record all the various logic and physical states of the system. This type of diagnostic capability will become more useful, and almost a necessity, as personal computers become more complex.

Eliminating Disks and Pirates

Distribution of personal-computer software has its problems, most of which fall into two main categories: media reliability and piracy. Almost all personal-computer software is distributed on floppy disks, a magnetic recording medium. The data-transfer head reads and writes information as the disk revolves. The data-transfer head must make physical contact with the floppy disk in order to work properly. This contact causes friction that eventually wears out the floppy disk. Dirt, dust, oily fingerprints, and other types of contamination can accelerate this deterioration. Because memory cards have no moving parts, they are very resistant to the contaminants that can ruin a floppy disk. Therefore, memory cards are a more reliable distribution medium than floppy disks.

Memory cards also offer protection against software piracy. Currently, a personal-computer user needs to keep several copies of a program on separate disks to ensure a working copy in case of an operator error or media failure. Because copies are easy and necessary for legitimate users to make, they are also easy for illegitimate users to copy. This is a major problem in the industry today and one that can be easily combated with memory cards, which cannot be erased by the user or be easily damaged.

Memory cards are more reliable than floppy disks and offer protection against software piracy.

Chip-based memory cards can store approximately 5 percent of the information of a single-sided, single-density 5¼-inch floppy disk (8K bytes versus 160K bytes). Technological advances may help to overcome this drawback.

Alternately, a multiple-card reader could be constructed for virtually the same cost as a floppy-disk drive (approximately $400). A card reader would enable many programs to be on line simultaneously with improved access time and enhanced reliability.

Chip-based memory cards are not the only type of memory cards that can be used to store information. Optical-stripe memory cards can store about 4 million bytes per card. This lets a large program or a multitude of smaller programs be stored on the memory card, which greatly increases the applications for personal computers. By using an optical-stripe memory card, books, dictionaries, thesauruses, encyclopedias, and reference books could be bought in machine-readable form inexpensively. Imagine a spelling checker based on a 4-million-byte memory card. A reader for an optical-stripe memory card would be more expensive than one based on chip technology, but if manufactured in large quantities, its cost would probably range from $400 to $800. The reader would be about the same size as the current 5¼-inch floppy-disk drive.

Although the technology is yet in its infancy, memory cards may eventually be used by the majority of the population. Applications include security, financial tasks, data storage, and diagnostic capabilities for personal computers. As yet, it is not clear whether active or passive cards will prevail, but memory cards will be part of your life very soon.■

Mark Mills is facility manager of the Microcomputer Application and Technology Center at Battelle Columbus Laboratories in Columbus, Ohio. He can be contacted at 3118 Essington Dr., Dublin, OH 43017.

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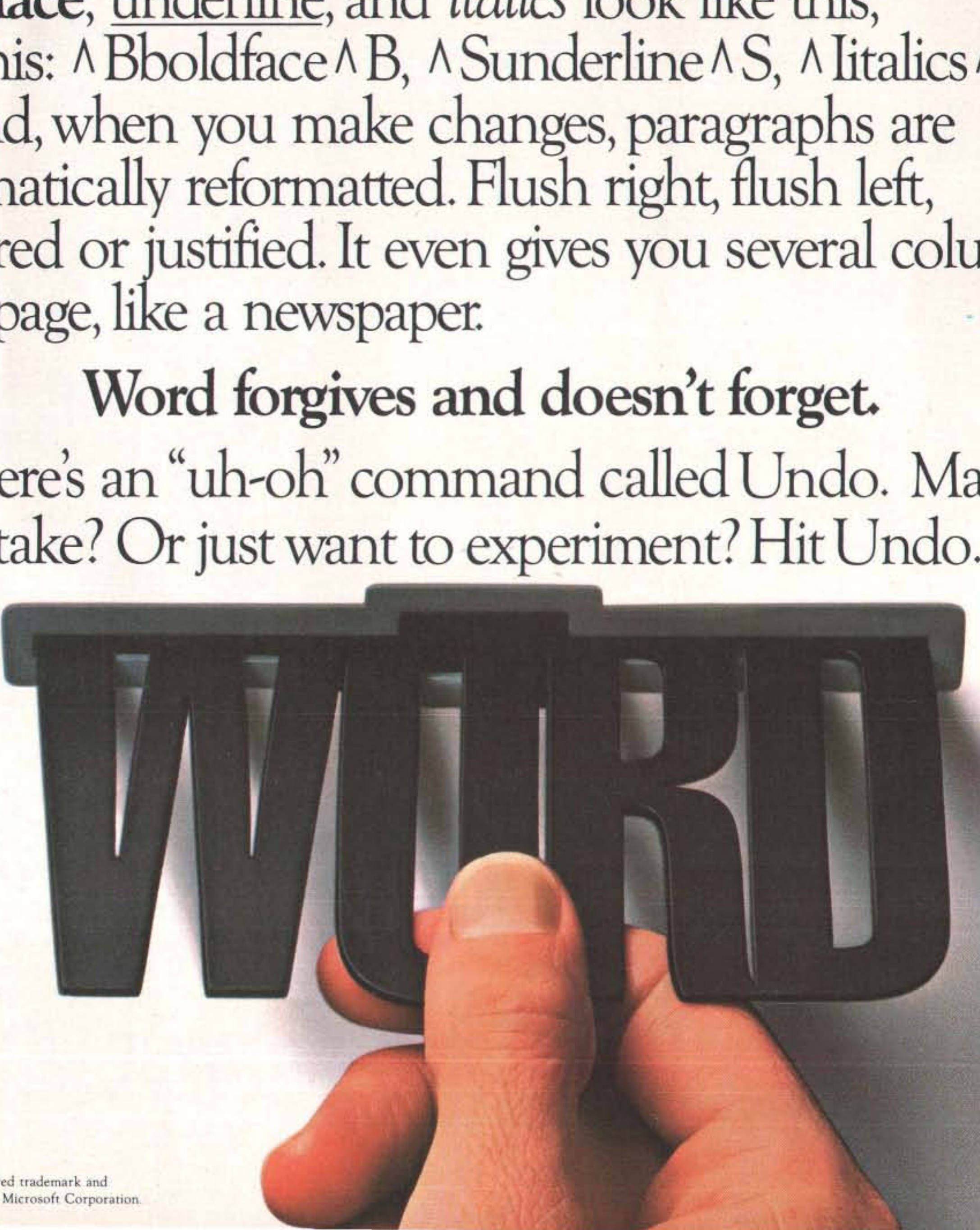
There's an "uh-oh" command called Undo. Make a mistake? Or just want to experiment? Hit Undo.



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Mouse. Finally.

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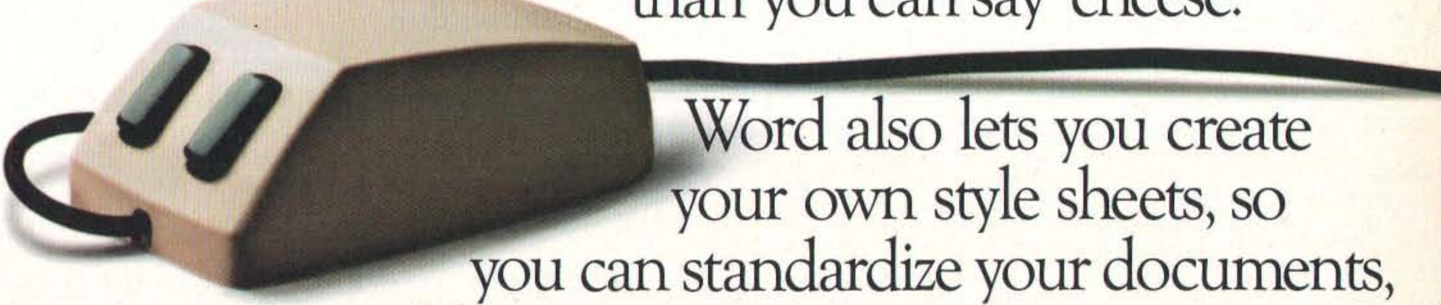
Word travels fast.

Word has a Mouse, a handy little critter that lets you move copy, select commands and edit faster than you can say "cheese."



Word also lets you create your own style sheets, so you can standardize your documents, memos, files and letters.

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Computer-aided Design

Significant CAD power is coming for desktop microcomputers

by Rik Jadrnicek

Computer-aided design (CAD), drawing and designing with the aid of a computer, promises to change our lives dramatically. Not so long ago, we stumbled into air-conditioned computer centers with boxes of keypunch cards and a desire to "see " what would happen. Now all that power sits on our desktops, and as a result pencils, erasers, and perhaps even paper face the prospect of obsolescence.

Today, word processors conquer mountains of text, electronic spreadsheets master number manipulation, and business graphics translate the results into charts, graphs, and slide shows worth a thousand words. And the increasing number of electronic pictures in turn creates the need for a graphics editor—a picture processor similar to a word processor. That way, we can create and edit graphics images, cutting and pasting our way through letters, numbers, and pictures.

The age of computer graphics is finally here. A hardware/software configuration exists for everything from painting illustrations with a color brush to designing and automating the production of a pipe valve. Software tools can manipulate both two-dimensional and three-dimensional images, tools that enable us to create geometric models worth a thousand pictures.

But increased capability and falling prices raise serious questions. What hardware and software do you need? What is available? How do you compare packages? What do the terms mean? Whom do you contact? Should you wait to buy? Unfortunately, the pattern is far too familiar.

This article charts a path through the jungle of hardware and software considerations you face when choosing a CAD package. In it I focus on some of the software and hardware available for your desktop computer.

What Is Computer-aided Design?

Computer-aided design has many potential applications, among them graphics design, illustration, flowcharts, block diagrams, forms design, mapping, printed-circuit board/electrical design, space planning, architectural design, mechanical drafting, and product design. A discussion of solids modeling with shading, animation, and image synthesis on microcomputers is a little premature, but several powerful wire-frame-type three-dimensional modeling packages are available along with some exciting painting software (see photos 1 and 2).

Computer-aided engineering (CAE) ties together such diverse interests as pictures (schematics, assembly and maintenance drawings), cost analyses, structural analyses, production process plans, material specifications, tool design, and quality control. During this process, CAD graphics interface with a variety of analysis packages through compatible data files.

Computer-aided manufacturing (CAM) uses CAD and CAE criteria to produce a product such as a valve, a tool, or another item. Soon we'll be able to design, analyze, document, and organize the actual manufacture of a product from the original drawing. Both CAE and CAM operations are in their infancy on desktop micros.

With CAD, you draw or edit by entering data through a keyboard or a variety of input devices such as digitizers, mice, light pens, touch pens, trackballs, and image digitizers. The graphics software records the drawing within a world coordinate system and saves its database description. You edit the database and view the results on a monitor, which sends the image you create to a variety of hard-copy output devices including printers and plotters. You can network the database and send it out via modem or create an interface with such programs as Bill of Materials, Stress Analysis, or a variety of CAE/CAM applications.

What Is Available?

Historically, computer graphics started with the early Teletype and

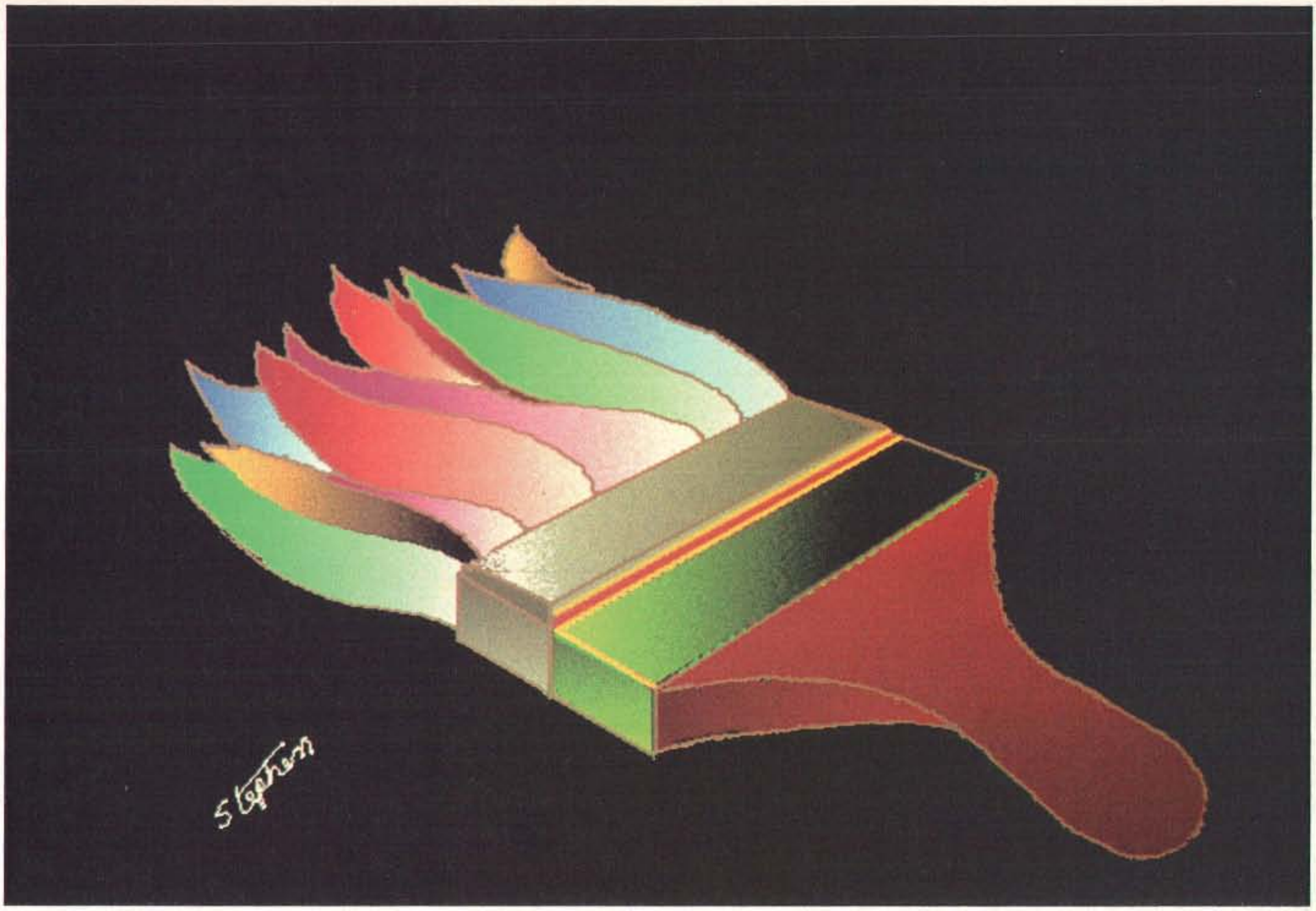

Photo 1: *A paintbrush drawn with the pixel-based Easel painting software.*

line-printer hard-copy devices of the 1940s. Computer-driven CRTs (cathode-ray tubes) began to display output in the early 1950s. In 1962, Ivan E. Southerland, a young Ph.D. from MIT, formally described a computer system that enabled users to draw. Significant developments in output-device technology and software in the 1970s have made Southerland's dream economically feasible. Currently, more than a dozen software developers are well along the path to creating significant CAD power for desktop computers. These are not expensive dedicated systems or bundled hardware and software configurations that are device dependent; they run on stock microcomputers with few exceptions.

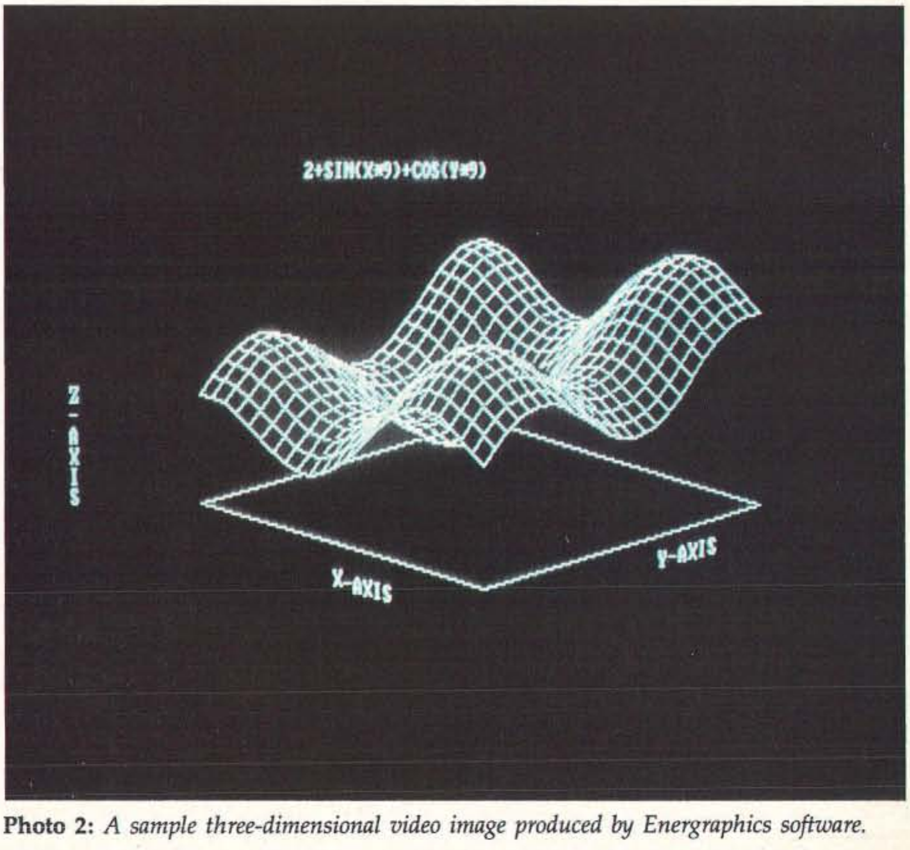

Photo 2: *A sample three-dimensional video image produced by Energraphics software.*

Hardware Requirements

The costs of the hardware and software necessary to configure a CAD system run from $5000 for a very fundamental floppy-disk system up to

Processor Support	PC-Draw	CADdraft	Benchmark	Vector Sketch	Drawing Processor	CADplan	AutoCAD	VersaCAD
IBM PC	•	•	•	•	•	•	•	•
IBM PC XT	•	•	•	•	•	•	•	•
Columbia	•	•		•	•	•	•	•
Compaq	•	•	•	•	•	•	•	•
Corona				•	12/83			•
Eagle PC	•	•	•	•	•	•	•	6/84
Eagle 1630					•		12/83	
TI PC							•	
NEC APC			•		1/84		•	
Zenith Z-100					1/84		•	
Compupro							•	
Televideo							12/83	
Victor 9000		•	•		1/84	•	•	
Digital Microsystems							•	
DEC Rainbow			1/84				12/83	
DEC 350								6/84
Apple II								•
CP/M					•		•	
HP-200 Series								•
Price	$250	$495	$595	$900	$995	$1295	$1000/$1500	$1995

Table 1: *A comparison of computers.*

• = existing feature
date = expected release date

Input Devices	PC-Draw	CADdraft	Benchmark	Vector Sketch	Drawing Processor	CADplan	AutoCAD	VersaCAD
Sunflex Touch Pen							•	
Sunflex Touch Pad		•				•	•	
Light Pen	•							
Joystick								•
Houston Instrument Hipad		•	1/84		•	•	•	•
Hitachi Tiger Tablet							•	4/84
GTCO		•		•	•	•		•
Summagraphics			1/84		•		•	•
Kurta			•					4/84
Mouse Systems Mouse		•				•	•	
USI Optomouse							•	

Table 2: *A comparison of input devices.*

• = existing feature
date = expected release date

$50,000 for a dual 68000-based microprocessor with a 20-megabyte hard disk and 1 megabyte of RAM (random-access read/write memory). The latter system is capable of very good two-dimensional and three-dimensional commercial animation graphics.

Ideally, the CAD software you choose will support a variety of computers (table 1), input devices (table 2), graphics processors, and output devices (table 3).

Computers

A wide variety of desktop microcomputers can be configured for computer graphics work. This added capability usually doesn't interfere with the word processor, the spreadsheet, or any other software in your library.

These computers fall into four general categories:

1. Atari, Apple, and other computers with proprietary operating systems using the 6502 microprocessor chip. Accelerator boards provide 8088 and 68000 chips for some of these.
2. S-100, STD, Multibus, and other systems like the Victor 9000 using the Z80 or 8086, 8087, and/or 8088 microprocessors.
3. IBM PC XT and the growing number of PC look-alikes using the 8086/8088 microprocessor and optionally the 8087 numerical data coprocessor.
4. Unix systems using the Motorola 68000 microprocessor.

The Intel 8088 microprocessor is faster and more powerful than the Z80 but less powerful than the Motorola 68000. Some systems, such as the Victor 9000, come from the fac-

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	2213	2215	2235
Bandwidth	60 MHz	60 MHz	100 MHz
No. of Channels	2	2	2 + Trigger View
Alternate Sweep	—	Yes	Yes
Vert/Trig B/W Limit	—	—	Yes—20 MHz
Single Sweep	—	—	Yes
Accuracy: Vert/Horz	3%	3%	2%
Delay Jitter	1:5,000	1:10,000	1:20,000
Trigger'g Sensitivity	0.4 div at 2 MHz	0.4 div at 2 MHz	0.3 div at 10 MHz
Input R-C	1MΩ −30pf	1MΩ −30pf	1MΩ −20pf
Variable Holdoff	4:1	4:1	10:1
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Output Devices	PC-Draw	CADdraft	Benchmark	Vector Sketch	Drawing Processor	CADplan	AutoCAD	VersaCAD
Graphics Boards								
IBM Graphics Board-Color	•	•				•	•	•
IBM Graphics Board-B&W	•	•	•	•	•	•	•	6/84
Single-Screen Version	•	•				•	•	
Hercules					•		•	2/84
Scion		12/83		1/84		12/83	12/83	
Techmar	3/84						12/83	2/84
Control Systems Artist		12/83				12/83		2/84
Color + Plantronics	3/84	•	1/84			•		•
Vectrix 384							•	
Pen Plotters								
Houston Instrument:								
DMP-7					•		•	•
DMP-8					•		•	•
DMP-29	•	•			•	•	•	•
DMP-40	1/84	•	•	•	•	•	•	•
DMP-41	3/84	•		•	•	•	•	•
DMP-42	3/84	•		•	•	•	•	•
Hewlett-Packard:								
HP-7470A	•	•		•	•	•	•	•
HP-7580	•	12/83		•	•	12/83	•	•
HP-7585	•	12/83		•	•	12/83	•	•
IBM XY749	1/84	•		•		•		
IBM XY750	1/84	•		•		•		
Calcomp		•				•	11/83	
Sweet-P			•				•	4/84
Strobe 100				•			•	
Strobe 8-pen				•			•	
Graphics Printers								
Epson MX-80	•	•	•	•		•	•	2/84
Epson MX-100	•	•	•	•		•	•	2/84
Epson FX-80/100	•	•	•	•		•	•	2/84
Citoh 1550	•							
IBM Graphics	•	•	•			•	•	2/84
Okidata 84/92	•							
Okidata 93	•							
NEC 8023	•		•					
NEC PI			•					
Mannesmann Tally	•		•		•			
Gemini-10/15	•							
IDS Prism	•							
Versatec		1/84				1/84		

Table 3: *A comparison of output devices.*

• = existing feature
date = expected release date

tory equipped with full graphics capability. They are the easiest to configure and generally the least costly. If you do need to configure a system for graphics capability, in a price/performance evaluation the IBM PC and its look-alikes come out on top, followed by selected S-100 systems (see photos 3 and 4).

Input Devices

Although you can use the keyboard as a primary input device, a specialized device is much easier and more efficient.

With manual drafting methods and a conventional drawing board, you physically draw a line from one point to another. You do the same thing with a digitizer or digitizing tablet (electronic drawing board), but rather than use a pencil or pen you use a *puck*, cursor device, or stylus. You can trace a library of drawing parts you have created over the years for use in assembling your current drawings. You can also work with drawings created manually by your co-workers.

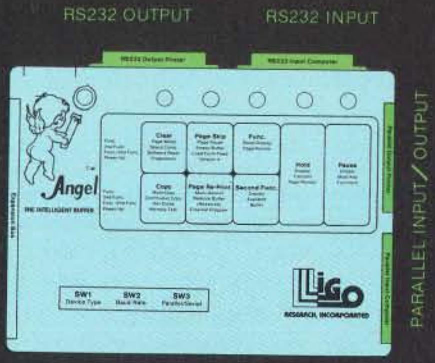
Touch pens and light pens enter data points directly onto the monitor screen—if you don't mind holding your hand in the air—but they don't trace manually created drawings.

Similar to digitizing tablets but without the expense or the accuracy, mice keep your hand in a restful position on a table or grid plate. Trackballs, which use a revolving ball like some video games, video-camera input, and even joysticks are available. It's a good idea to combine the key-

Text continued on page 180

Let the *ANGEL* do the waiting . . . . . .

It has been said that 30% of microcomputer users will eventually purchase a buffer. For business users, a buffer pays for itself in the time and money it saves the user not waiting for the printout. The more you use your printer the more you need a buffer.



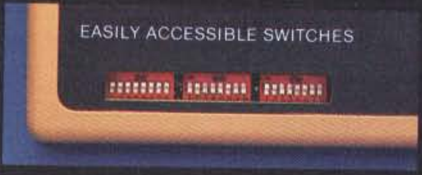
ANGEL HAS ALL INTERFACES

ANGEL, The Intelligent Buffer is the perfect mate for your system. It has both RS232 Serial and Centronics Parallel interface, and can convert from serial to parallel and parallel to serial. It is truly a universal buffer that is compatible with most microcomputer systems. This versatility means when you upgrade your system you can use the same ANGEL.

ANGEL passes data to the printer exactly as received from the computer and is independent of software — including graphics. The ANGEL also features an innovative page mode which carefully monitors the page break data during printing. Under the page mode you can reprint the last page, jammed pages, do page skip as well as page pause for single-sheet feeding.

ANGEL is an intelligent buffer with 12 additional functions that may be activated when you need them; pause, hold, copy, clear, self-test, page reprint, page skip, page pause, multi-copy, continuous copy, space compression, hex dump, etc.

ANGEL comes with 64K bytes of memory, ample for most applications. Additionally, you may activate the space compression mode which in may cases extends the buffer capacity to more than 128K.



ANGEL is designed for all types of users – even those without technical background. All switches, including baud rate selection and parallel / serial configurations are externally accessible. Installation is a matter of connecting cables, setting up DIP switches and power-on. Ligo Research makes available standard cables/adaptors for most popular computer/printers. Connection diagrams are also provided for users who want to make their own cables.

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Software Features to Look For

On-line Status

On-screen status items, such as layer number, grid status, lines of type, the cursor's x-y coordinate position, and various interactive prompts, are helpful. The ability to get information about your drawing or entities within it is also helpful. For example, if you want to know the size of your coordinate system, the exact location of a particular item, or the default status of various program parameters, the on-line status feature gives you access to this information.

Menus

While it is cumbersome and frustrating in the long run to choose program functions from an A, B, C type of menu, command menus that you point to on the screen are a desirable feature. In addition, if you have the freedom to design your own menu, you can develop a custom application using only those selections that apply to your drawing needs. For example, you may want to use only 10 of the 40 menu commands and organize them conveniently for your own frequency of use. The program may let you put predefined shapes (icons) in the menu for easy selection and placement in your drawings.

Macros and Command Files

Macros and command files are groups of program instructions and other data-entry items that can be executed with a single keyboard sequence. For example, if it takes you five steps to merge a disk file into your current drawing, you can place the necessary instructions in a macro/command file and execute it with a single command. You can even place these macros as selections on your menu.

Further custom flexibility exists if the software lets you stop during macro execution and issue a prompt for data entry. For example, you can develop a menu item that creates a shape; goes to a particular location; enters text mode; sets the font, size, and direction; and prompts you to enter the text string. The more powerful the macro capability, the more you can develop custom or turnkey applications.

Ideally, you can enter the program and execute the first command by making one entry at the A>prompt. This allows you to enter the program from a batch file, draw for a while, perform some other macro functions, exit cleanly, and then reenter the original batch file. Turnkey CAD, CAE, and CAM operations then become feasible.

Grid

The world coordinate system and the coordinate system you define within it break down into grid points that serve as reference points while you are drawing. Look for the ability to specify the distance between grid points and to choose a different scale for the x and y axes. You don't want the grid points to become part of the database or to appear on the printer or the plotter. Ideally, they turn inverse when they appear in a solid fill.

When you activate grid lock or grid snap, another desirable feature, the data points you enter "snap" to the nearest grid point no matter where you enter them. This permits a degree of error when entering data points. Notice in the figure opposite how the actual figure (solid line) differs from the digitized line (dotted). This is especially helpful when you are trying to align different drawing layers, close irregular shapes, or enter data points quickly and accurately.

The ability to vary the distance between grid points becomes important with grid lock/snap. It allows you to change the coarseness of your drawing resolution as you fine-tune. You can, for example, zoom in on one square inch, snap to the nearest hundredth-inch for detail drawing, then zoom back out, snapping to the nearest quarter-inch.

With the incremental snap feature, your cursor stops only on grid points or resolution points as it moves across the screen.

Aspect Ratio

If "what you see is what you get" is important to you, make sure the program corrects for the aspect ratio of your display devices. Aspect ratio is a design engineering term that refers to the ratio of display width to height. For example, a 320 by 200 monitor presents a circle as an ellipse and a square as a rectangle unless the software makes the right adjustments. This is quite important if proportion matters during data entry or if you are using the display for a final presentation.

Data Entry

Shapes, blocks, groups, components, and dictionary items. *These are all different names for similar drawing elements. You want to be able to create drawing elements, store them in a parts library, and merge them into your current drawing, rescaling and rotating them as desired. The ability to automate repetitive drawing tasks is one of the more important features of a CAD program. For example, if you are an architect and want to call one of a variety of drainage systems into a foundation/site plan, you can retrieve the right one from your drawing library on disk rather than redraw it from scratch.*

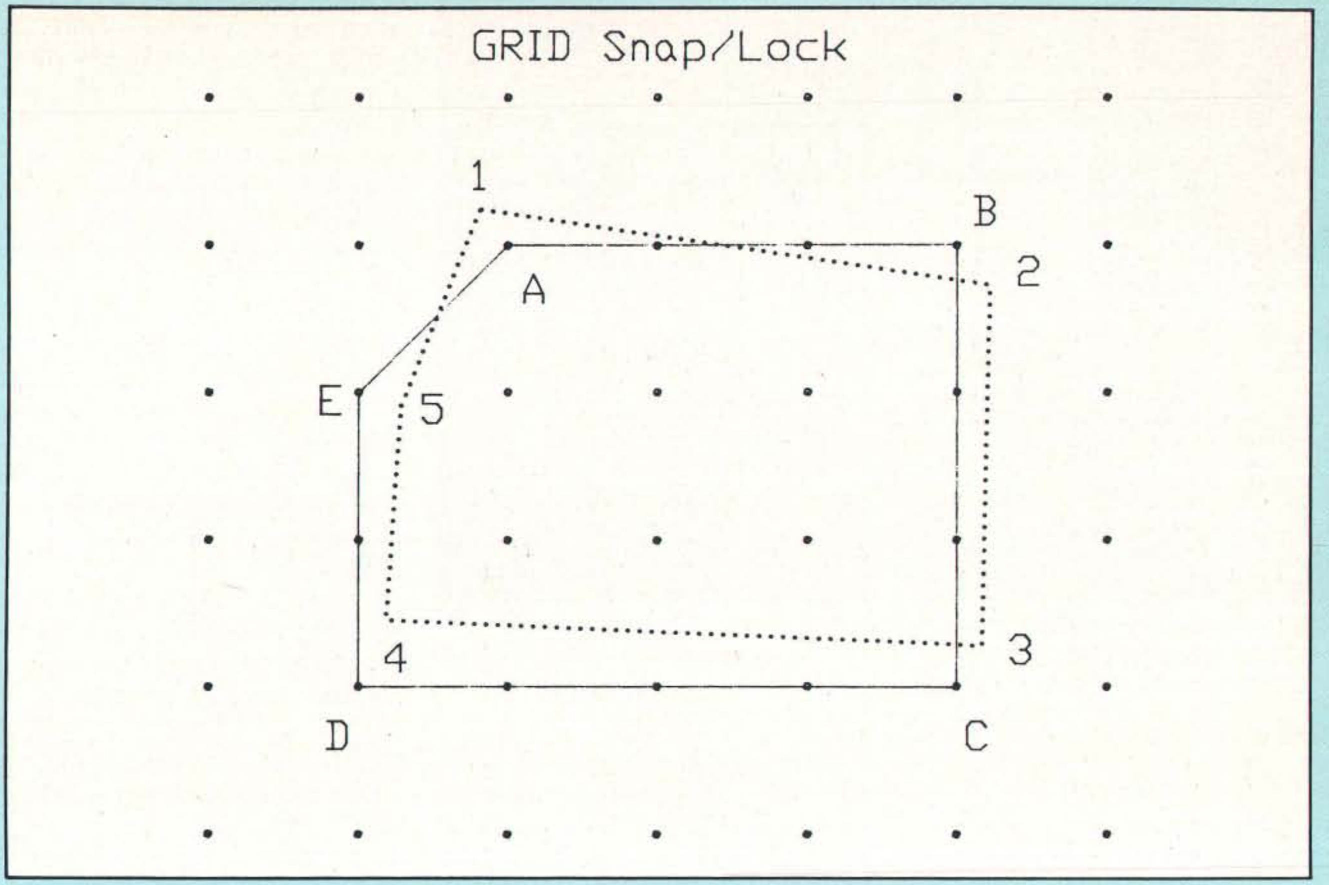
Tablet or tracing mode. *This can be extremely important for merging existing manual drawings into your library. Look for the ability to enter a drawing that is larger than the surface of your input device. For example, you may want to enter a 24- by 36-inch drawing you did 10 years ago through your 11- by 11-inch digitizer tablet and make it part of your drawing library on disk.*

Keyboard entry. *The ability to enter data from both a keyboard and an optional input device is desirable. Positioning the cursor, entering relative or absolute coordinates, and keying formulas that result in appropriate curves are all important. Absolute coordinate entry is essential.*

Freehand draw or sketch mode. *Drawing from vector point to vector point and snapping to grid points has its advantages, but so does sketching a freeform line. Different programs handle this capability quite differently. Sometimes the sketched line becomes one database item; other times the software stores it as a user-defined collection of data points. If this capability is important to you, look at the method of updating the database, the amount of storage used, and the flexibility available for manipulating your sketches.*

Drawing primitives. *Become familiar with the primitives (lines, arcs, circles, rectangles, etc.) and attributes (line type, width, color, etc.) available in a particular program. Also check the number of ways you can define an object. For example, you may want to define a circle as a center and radius, two points determining a diameter or three points on the circumference.*

Many other primitive capabilities are shown on the accompanying tables. They include cross-hatching or filling an area (with or without user-definable patterns), fillets and Bezier curves (see glossary on page 208), and built-in math calculations.



Grid snap permits the perfect alignment of data points by forcing them to snap to predefined grid points. Note the solid-line shape you create even when you enter points in the dotted-line shape. This becomes important when registering one layer of a drawing with another.

If you need autodimensioning, be sure it suits your needs. Some things to look for are angular, radial, and autostacking features and the ability to customize dimension elements.

The primitive features available in CAD software vary widely. The more flexibility you have to customize the primitives, the happier you will be in the long run.

Layers. *If the CAD software provides multiple layers, your drawing power magnifies. Layers are like pieces of tracing paper stacked one on top of the other that you turn on and off individually for display and hard-copy output. For example, if you are designing a house, you can develop a site plan on layer one, a foundation plan on layer two, a floor plan on layer three, an electrical plan on layer four, a plumbing plan on layer five, and a roof plan on layer six. This enables you to see the overall house with all its details integrated while you have the freedom to see and draw each individual plan independently. If you turn off all the layers except the electrical plan, you can send that plan to a hard-copy device. If you turn on the floor plan, you can conveniently work on your electrical drawing against the appropriate background.*

Rubber banding. *A visual aid when drawing, the line stretches like a rubber band while you pull it to the next data point. Rubber banding helps in trying to conceptualize the drawing process.*

Editing Features

The ease and power of the editing capability are important considerations with CAD software. You must be able to manipulate the images you create while rescaling, rotating, and moving them around. This allows you to correct mistakes and freely modify your drawings.

If, in the example of the house plan, you previously completed a drawing of a house in a completely different scale from the site plan, the ability to load the old house plan and merge it with the new site plan while rescaling it and rotating it for proper sun exposure would be extremely helpful.

Partial delete. *A feature quite often absent in lower-priced CAD systems is the ability to delete part of a previously drawn image without having to erase and reconstruct the whole thing. For example, if you break a house wall and put in a window, you change the number of entities and data points updating the database. This feature, which is quite important in editing drawings, allows you tremendous flexibility. Without it, you need to preplan, resulting in a rigid drawing lacking in spontaneity.*

Windowing. *This is the process of defining an area you wish to manipulate by setting up two opposite corners of a rectangle that contains it. For example, you can window an area in order to delete, move, copy, save, or zoom in on it. With the rubber-banding feature, the window dynamically expands and contracts after you define one corner, so you can shape the window and see the area defined.*

Others

The list continues (tables 5, 6, and 7), but you can readily see that CAD is very powerful. The best test is an actual test; take a drawing in, try out the software, and make sure the features you need are there.

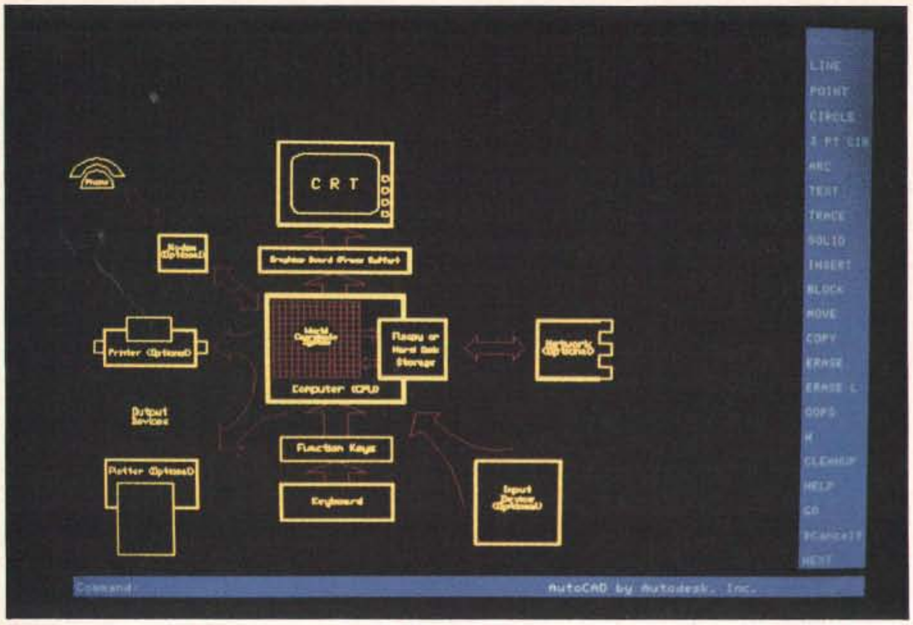


Photo 3: *The hardware elements of a CAD system drawn using vector-based AutoCAD software and displayed by a 640 by 400 Vectrix Graphics processor and high-resolution Vectrix color monitor. Note that much of the configuration is optional.*

Text continued from page 176:

board, function keys, and an input device determined by the design work you do. Look for software that supports a variety of input devices in case your preferences change.

Output Devices

If you desire a copy of your work, you will be using a hard-copy device. Choose CAD software that gives you output options—the more the better. A mature program supports a variety of devices that output drawings to dot-matrix printers, ink-jet printers, pen plotters, electrostatic plotters, or microfilm recorders.

For applications requiring accurate representation of colors and high-quality hard copy, such as painting packages, you can photograph the monitor. A variety of photographic and video interfaces are available.

Graphics Processors

The graphics processor and the graphics monitor determine the quality of the video-display image you view during editing. The processor translates the database image in RAM for display on the monitor. If either of these devices has poor resolution, the image is less than representative.

The area of video feedback during CAD work needs improvement and is getting it. The price of a high-resolution color processor/monitor combination dropped from $5000 to less than $2500 in one year. Many high-resolution graphics processor boards now available (Scion, Conographics, Techmar) are reasonably priced. Very high quality color graphics monitors range between $1500 and $10,000 at this time, but prices are approaching the economic means of the desktop computer user.

Drawing Resolution

The concept of resolution is important to understand if you wish to become aware of current and future trends in computer-aided design. The number of dots or elements used to represent an image determines its resolution. Consider drawing a straight line. Take a pencil and begin placing dots in a line from left to right on a piece of paper. Make the dots about ¼ inch apart. You are creating a low-resolution representation of a straight line. The finer your pencil point and the more dots you place within the line, the higher the resolution of your drawing is. If you place enough dots along the line, it appears to be a solid line. The same concept applies to circles, solids, text, and other shapes.

In general, the higher the resolution, the smoother and more accurate the image. Obviously, you want the highest resolution possible.

World Coordinate System

Each piece of CAD software has its own method of mapping a coordinate system, usually called the world coordinate system.

In a pixel-based system, the software maps out a coordinate system in RAM relative to the number of pixels available within the graphics processor/monitor. Each pixel becomes a coordinate point within the world coordinate system. You represent an image by the lit or unlit status of each pixel location (data point) in the image database. This method is com-

Photo 4: *One example of a CAD system, an IBM PC with a Houston Instrument Hipad 11 by 11 digitizer and DMP-40 plotter.*

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System Specs	PC-Draw	CADdraft	Benchmark	Vector Sketch	Drawing Processor	CADplan	AutoCAD	VersaCAD
Color output	•	•	1/84	1/84		•	•	•
Program load-time to draw	27 sec	36 sec	10 sec	28 sec	14 sec	45 sec	33 sec	81 sec
Minimum RAM required	128K	320K	256K	256K	256K	320K	256K	64/128K
Maximum addressable RAM	192K	320K	640K			640K	640K	128K
Disk I/O frequency	Med	Med	Med	Med	Med	Med	Med	High
Drawing entity bound	•	•		•		•		•
Drawing RAM bound	•	•	•	•	•	•		
Drawing disk bound	•	•	•	•	•	•	•	•
Copy/multiuse protection	Disk	RS-232		PROM		RS-232		Key/Card
Configuration utility		*	•			*	*	•
Z80 support							•	
8086 support	•		•				•	
8087 support		•	6/84	11/83	•	•	•	•
8088 support	•	•	•	•	•	•	•	•
80000 series support							•	
Machine/assembly	•	•	•		•	•	•	
BASIC	•	•				•		
C		•	•			•	•	
Pascal					•			•
FORTRAN				•				
World grid resolution	1280 by 400	65,000 by 65,000	65,000 by 65,000	0.002	1×10^{15} by 1×10^{15}	65,000 by 65,000	1×10^{15} by 1×10^{15}	1×10^{15} by 1×10^{15}
Floating-point					•		•	•
Integer	•	•	•	•		•		•
Vector base	•	•		•	•	•	•	•
Maximum vertices/entities	1400	5000		5000	10,000 pts. 8000 lines	65,000		50,000
Drawing file type	ASCII	ASCII	ASCII	ASCII	Pascal	ASCII	Binary	Pascal
Alternate file type			DIF		DIF		ASCII	ASCII
Autocorrect for aspect ratio of graphics monitor			•		•		•	•
Intelligent plot utility		•			•	•	*	•

Table 4: *A comparison of system specifications.*

• = existing feature
* = outstanding feature
date = expected release date

mon in painting software where you paint shapes by lighting up pixels within a fixed matrix. For hard copy, you dump the image pixel by pixel to an output device.

In a vector-based system, the size of the world coordinate system doesn't necessarily correspond to the processor/monitor resolution. If the software uses integer mathematics, the coordinate system may consist of approximately 65,000 by 65,000 data points. With floating-point math, the software may generate a world coordinate system with limits of 1×10^{15} by 1×10^{15} data points.

The number of data points the CAD software makes available within the world coordinate system determines the degree of resolution it can achieve. The more there are, the greater the potential for detail, and, in general, the slower and more memory-hungry the program (see table 4).

To set the scale for your drawing, you map out your own user-defined coordinate system or grid on the software world coordinate system. Say, for example, that you want to map out an area of 24 by 36 database units corresponding to a D-size sheet of architectural drafting paper. You want each database unit to be one inch, and you want to be able to break that down into divisions of 0.001 inch. Once you define your coordinate system, the system develops a database to record location and other attributes ascribed to the data points. In a vector-based system, a data point could be the center of a circle and the beginning of a line segment on layer 5 in the color green. The circle might be a predefined shape (or primitive) defined by a center point and a radius of 2 database units rather than a circle of data points.

Physical Resolution

To record an image electronically, you enter it into the world coordinate system through a keyboard, digitizer, mouse, or light/touch pen. To manipulate the image, you display it on an output device such as a monitor. If you want to produce a hard copy, you send the database to printers and plotters. Each of these I/O (input/output) devices has its own resolution (called physical resolution) independent of that of the coordinate system or the image.

Differences in Resolution

In figure 1, see how the same circle

Text continued on page 190

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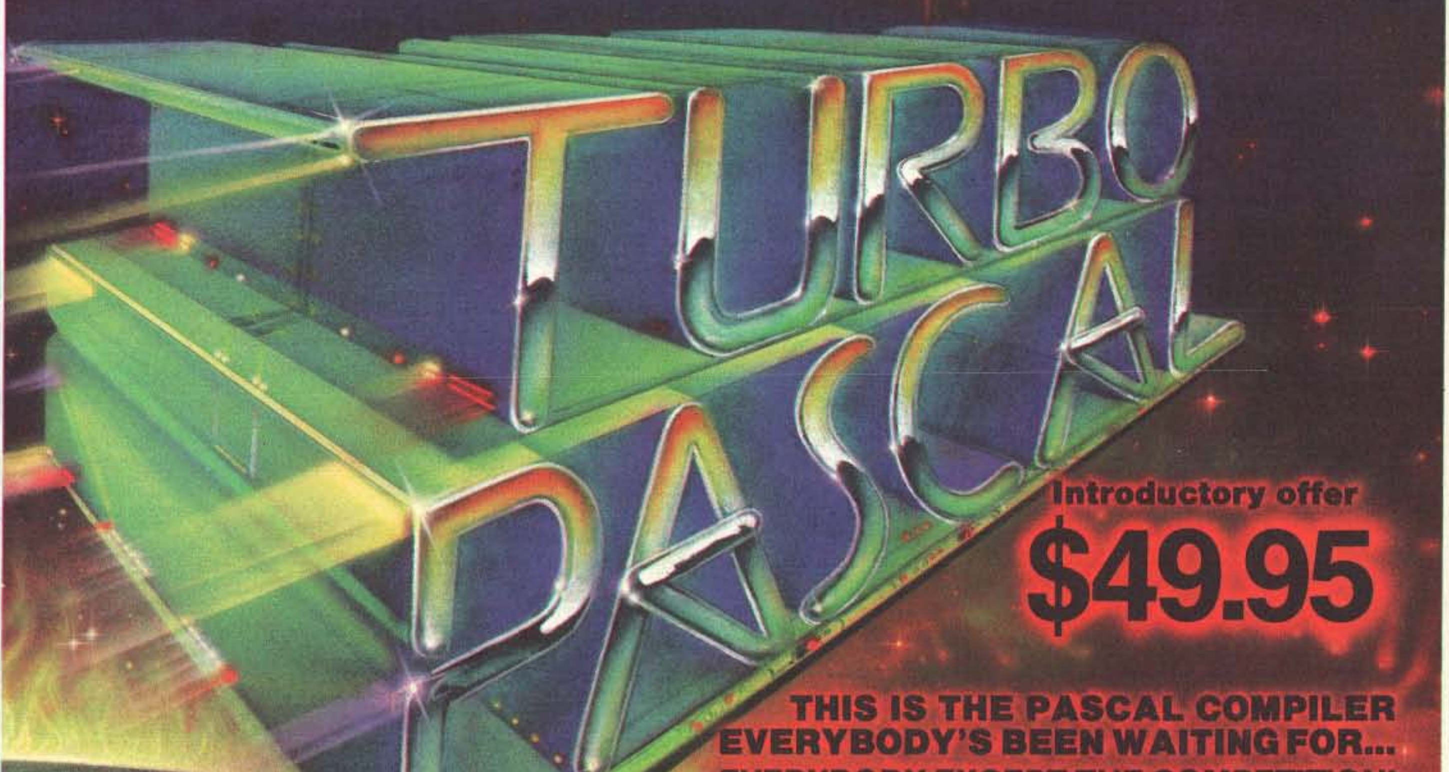

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8 bit	28K w editor!	Not Available	168K + editor
8 and 16 bit	YES	NO	YES
built-in editor	YES	NO	NO
Generate object code	YES	YES	YES
One pass native code compiler	YES	NO	NO
Locates RunTime errors directly in source code	YES	NO	NO

Benchmark data based on EightQueens in "Algorithms + Data Structures = Programs" by N. Wirth, run on an IBM PC.

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CAD Software Surveyed

Two-dimensional Software

AutoCAD
Autodesk Inc.
150 Shoreline Hwy., Bldg. B
Mill Valley, CA 94941
(415) 331-0356

AutoCAD is a powerful program capable of drawing anything from simple flowcharts to large, complex architectural drawings. Its strong points include a rich set of primitive commands, floating-point accuracy, little limitation on drawing size, good memory management, excellent peripheral support, and good editing features, including partial deletion of drawing elements. By means of user-definable menus, macros, and command files, AutoCAD can be customized without programming knowledge (a very powerful feature). A drawback, however, is that zooming, panning, and editing become slower as your drawing grows larger. This is typical for floating-point packages. If possible, use the faster 8087 numerical coprocessor with this program. You can zoom in from a view of the solar system to a desktop in a San Francisco office, but if you have a large number of elements in your drawing, the process may be slow. Aggressively updated and waiting only for a faster processor environment to complement its accuracy, AutoCAD has tremendous potential.

Benchmark
Metasoft Corporation
6509 West Frye Rd., Suite 12
Chandler, AZ 85224
(602) 961-0003
(800) 621-1908

A surprisingly capable CAD package, Benchmark uses macro command files to add flexibility, get around the limited number of standard features, and allow program customization. Written in machine and C languages, the program loads in a fast 13 seconds and executes commands just as quickly. Documentation is sparse, but the on-screen user interface is well designed and well written. Peripheral support is limited, however; Benchmark needs to support input devices other than the keyboard. More a graphics editor than a CAD system designed for detailed drawing, this program even contains business-graphics primitives. Keep an eye on Benchmark; it has a lot of potential.

CADplan
CADdraft
Personal CAD Systems Inc.
15425 Los Gatos Blvd.
Los Gatos, CA 95030
(408) 356-3183

A fast and friendly program with a lot of potential, CADplan's rich primitive features coupled with powerful editing features make it well worth considering. This is the only package reviewed that contains a user-definable database-extraction provision, allowing you to create written reports based on elements you place in your drawing. Its powerful configuration module supports a variety of peripherals. On the negative side, CADplan's integer math limits drawing size and resolution. Therefore, make sure this package handles the detail you require. Also, digitizer input is slow, and the system doesn't remap the device when you zoom in for more detail, i.e., you draw in a smaller area on the digitizer. Aggressively updated, CADplan is sure to become a popular entry-level package.

A scaled-down version of CADplan designed as a beginning package, CADdraft is rich in primitive and editing features and serves as an excellent introduction to CAD. Although the drawing size is limited, it may not hamper basic day-to-day drawing applications. Be sure the drawing resolution can provide the detail you desire since it is based on integer math. This program is fast, easy to use, aggressively updated, and supports a variety of peripherals. CADdraft is a good first step in CAD, especially if the more advanced CADplan suits your future needs.

Drawing Processor
BG Graphics Systems Inc.
824 Stetson Ave.
Kent, WA 98031
(206) 852-2736

Written in Pascal, Drawing Processor provides rich primitive features with a special curve-fitting provision not found elsewhere. This powerful program has strong editing features, sophisticated manipulation of predefined shapes, and floating-point precision. This precise but somewhat slow program requires an 8087 coprocessor chip. A well-illustrated manual describes how to map out an area on the digitizer and customize it for data entry. The program requires two monitors to run in some cases and doesn't support color yet. It needs to support a few more peripherals and provide more dimensioning and layered data-entry power. Drawing Processor is likely to be a top contender among CAD programs for micros.

PC-Draw
Micrografx
1701 North Greenville, Suite 703
Richardson, TX 75081
(214) 234-1769

PC-Draw provides a surprising amount of graphics editing power in an inexpensive package. You can create symbols, place them in a menu within the graphics editor, then pick these elements and place them within the drawing area. You can create and edit images from complex block diagrams to simple architectural drawings in color or black and white. Currently, the program supports only light-pen and keyboard entry input with a variety of output devices. Well documented, but not a full CAD system, PC-Draw provides the basic tools for a variety of drawing needs.

Vector Sketch
GTCO Tablet
GTCO Corporation
1055 First St.
Rockville, MD 20850
(301) 279-9550

Written in FORTRAN, Vector Sketch provides some powerful CAD capabilities. A certain number of data points spill out each second as you draw in sketch mode. Line types, commands from an on-screen menu, and creation of a symbol library are available. The program limits the number *of data points you can enter and the size of drawing you can create. When zooming into the drawing for more detail, however, it doesn't remap the digitizer. This means that a quarter-inch move on the digitizer can send the cursor completely across the screen, making detailed drawing difficult. While it currently supports a limited number of peripherals, Vector Sketch is being updated.*

VersaCAD
CADapple
T & W Systems Inc.
7372 Prince Dr., Suite 106
Huntington Beach, CA 92647
(714) 847-9960

VersaCAD and CADapple are different versions of a powerful floating-point program written in Pascal. The ability to overflow your drawing to disk eliminates the threat of being RAM bound. In fact, since Pascal limits the RAM used, the program is constantly accessing the disk, making a hard-disk system preferable. It can automatically set up the balance of available RAM as a RAM disk. Rich primitives, including a Bezier curve-fitting provision, strong editing features, the ability to save views, a screen-dump provision, and partial deletion of drawing entities make this program powerful. Floating-point precision results in slower execution even with an 8087 coprocessor. The program can require two monitors and supports a variety of peripherals. With an optional three-dimensional interface now available and tremendous potential, VersaCAD/CADapple promises to become a popular package for micros.

Three-dimensional Software

The potential of three-dimensional software becomes desirable the more you work with CAD. Think how much time you could save by drawing house plans and then taking a three-dimensional look at the results from the neighbors' second-story window. Certainly, we anxiously await economical and usable three-dimensional CAD on desktop micros.

Many three-dimensional programs are available, but they are expensive. Several vendors have systems ranging from $15,000 to $40,000 and are considering introducing device-independent programs for micros.

Currently, a variety of interesting, inexpensive, and aggressively updated packages provide limited two-dimensional capability along with three-dimensional modeling features. Some of these follow.

Energraphics/PC
Enertronics Research
150 North Meramec, Suite 207
St. Louis, MO 63105
(314) 725-5566
(800) 325-0174

Chock full of features for less than $300, Energraphics includes business graphics, two-dimensional drawing with shapes libraries, and three-dimensional drawing with formula surface generation. It needs digitizer input. With excellent, well-illustrated documentation including its own software and many tools, this is an excellent entry-level package for learning about CAD.

MCS Software
3-D Space Tablet
Micro Control Systems Inc.
143 Tunnel Rd.
Vernon, CT 06066
(203) 872-0602

MCS is a three-dimensional modeling package complete with a special digitizer for three-dimensional data entry. You can digitize a small three-dimensional stick figure and then rotate, edit, and rescale it on the monitor. This package also allows two-dimensional digitizer input that you can then transform into a three-dimensional image with a high degree of accuracy.

3Design
3Design
POB C-56789
4710 University Way NE, Suite 1512
Seattle, WA 98105
(206) 525-7820
(800) 392-9210

Available for less than $300, 3Design is a three-dimensional stick-modeling package that constructs images as a collection of polygons and includes hidden-line removal and colored surface shading. Aggressively updated, this is an excellent entry-level package.

Painting

Painting software refers to pixel-based programs oriented toward graphics artists and illustrators, including the manipulation of images from a video camera. You can paint pictures on the monitor with a keyboard or digitizer. These packages will get more publicity as higher-resolution graphics processors and monitors become more economical. Descriptions of two programs follow.

Easel
Time Arts Inc.
4425 Cavedale Rd.
Glen Ellen, CA 95442
(707) 996-4856

A phenomenal package, Easel lets you paint on the monitor with a digitizer using different brush widths and even airbrush simulation. A palette of colors appears on the screen ready to touch and paint. Although most of the package is written in FORTH, many machine-language primitives are available. You will hear more about Easel.

4 Point
International Microcomputer
Software Inc.
633 5th Ave.
San Rafael, CA 94901
(415) 454-7101

With 4 Point, you can paint pictures on the screen and manipulate them, making copies of parts, changing background colors, and even switching images between buffers to create simple animation. You can turn off all status prompts to photograph the monitor image, or you can output your drawing to a plotter. Although you can use a mouse for data entry, this package needs more input devices to create more detailed and accurate drawings. Keep an eye on 4 Point.

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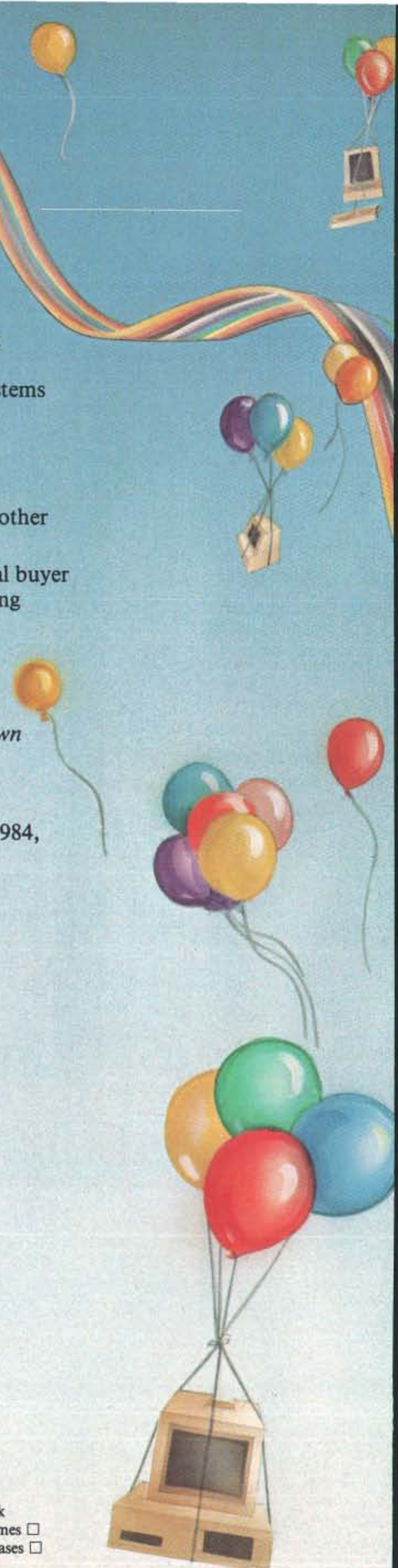

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Cambridge, MA 02142
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Jericho, NY 11753
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Box 8000, SAS Circle
Cary, NC 27511
(919) 467-8000

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10505 Sorrento Valley Rd.
San Diego, CA 92121
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Chatsworth, CA 91311
(213) 700-7888

Cascade 12.5 Designer
Cascade Graphics Development
1000 South Grand Ave.
Santa Ana, CA 92705
(714) 558-3316

Design Graphix
Engineering Systems Corporation
POB 80318
Baton Rouge, LA 70898
(504) 769-2226

MGI
Microcomputer Graphics Inc.
POB 10819
Marina Del Rey, CA 90295
(213) 822-5258

Summadraft
Summagraphics Corporation
35 Brentwood Ave.
Fairfield, CT 06430
(203) 384-1344

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Dasoft Design Systems Inc.
2550 Ninth St., Suite 113
Berkeley, CA 94710
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Boulder, CO 80301
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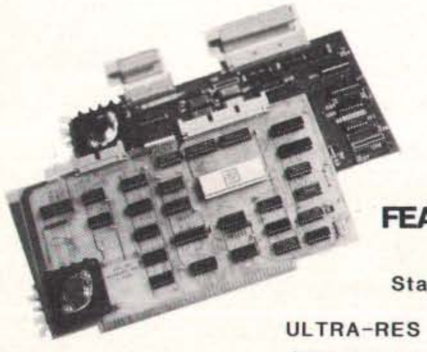

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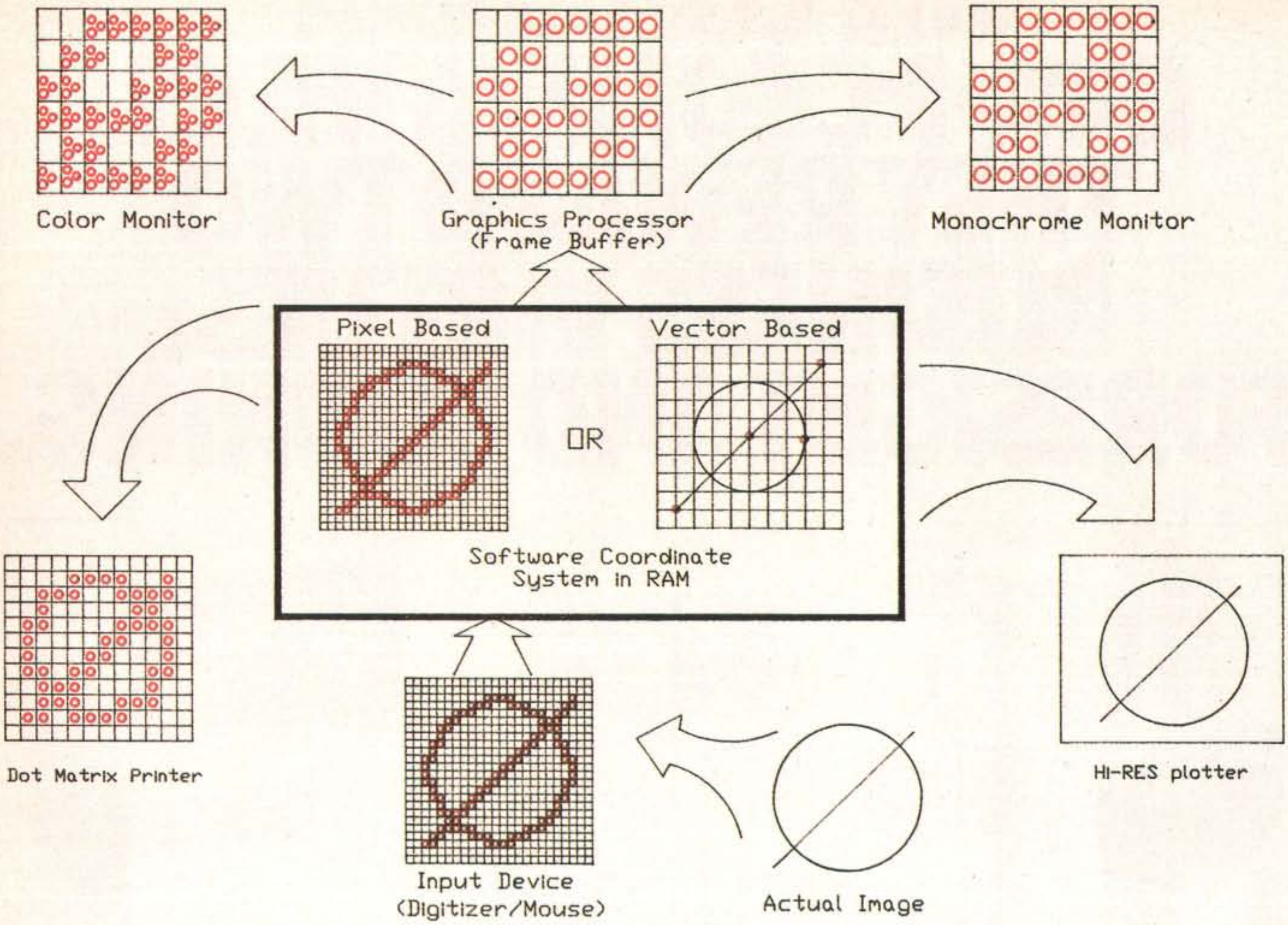

Figure 1: *Even when the monitor represents the drawing poorly, you can record an accurate database and produce a very high resolution hard copy.*

Text continued from page 182:

and line appear when represented by a variety of coordinate systems. Each system has a different number of data points to represent the image. Fewer data points provide lower resolution and cruder representation, resulting in jagged lines called *stairstepping* or *aliasing*.

Consider an input device capable of recording data points with a resolution of 0.001 inch and a coordinate system capable of 1000 data points per inch.

If you map the coordinate system created by the CAD software to the available pixels on the graphics monitor (see figure 2), an input resolution of 0.001 inch is too detailed for a world coordinate system of 320 by 200 pixels or even 2400 by 2400. This resolution is adequate, however, for a painting program where you either take a photograph of the monitor or do a pixel-by-pixel dump onto a hard-copy device.

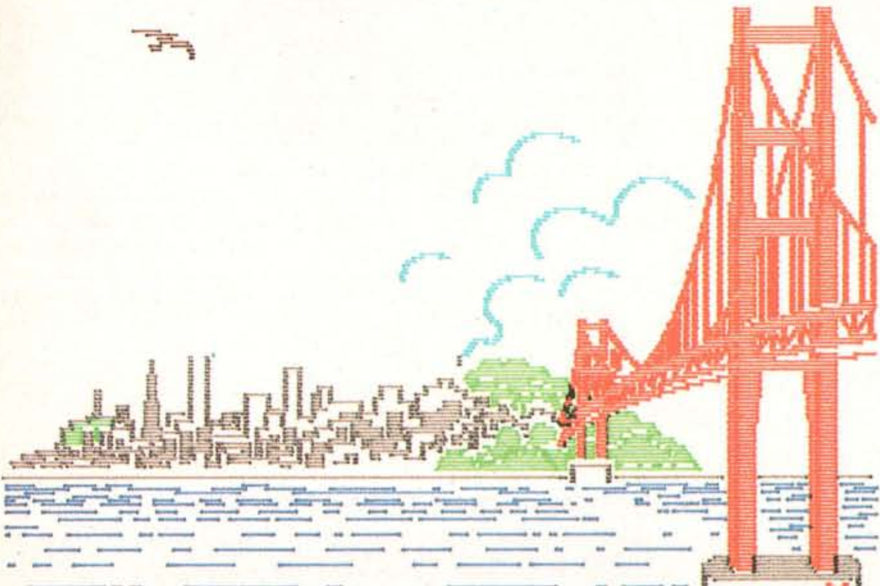

Figure 2: *An image of the Golden Gate Bridge drawn with the 4 Point painting package and plotted on a Sweet-P plotter. Note the series of short lines that represents the image on a pixel-based system.*

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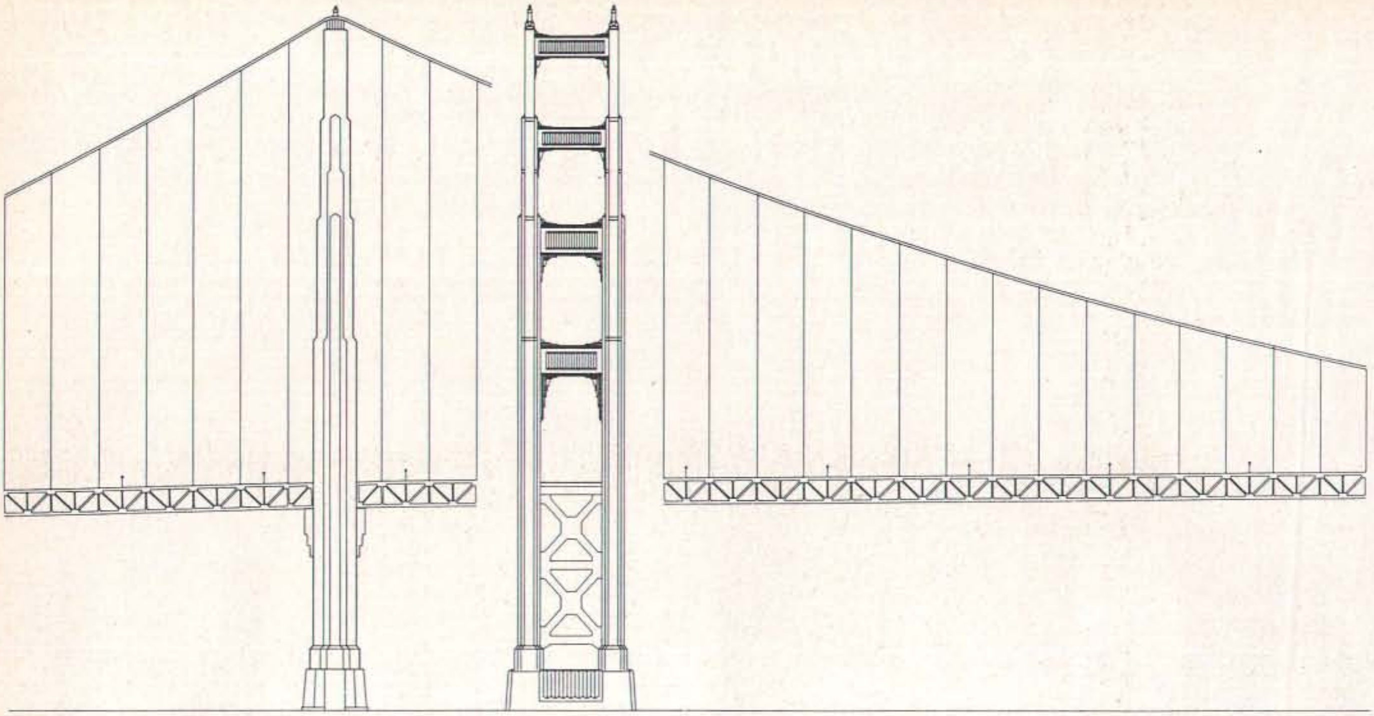

Figure 3: *An image of the Golden Gate Bridge drawn with high-resolution, floating-point, vector-based AutoCAD software and plotted on a high-resolution Houston Instrument DMP-42 plotter.*

In an integer-based program with a world coordinate system of 65,000 by 65,000 data points and a scale of 1000 data points per inch, you create a 65- by 65-inch coordinate system to an accuracy of 0.001 inch. The input resolution matches that of the software coordinate system.

With a floating-point-based program (see figure 3), a potential resolution of 1×10^{15} by 1×10^{15} data points more than accommodates the capability of the 0.001-inch input device. Zooming and viewing allow you to take advantage of this difference.

Although the software database accurately records the image received from the input device in these last two examples, when you send the image through the graphics processor and onto the monitor, the results are often less than satisfactory. The physical resolution of the display device has nowhere near the resolution capability of either the input or software world coordinate systems. The software records the image accurately, but the best available video representation is not all that good.

Now consider an output device, such as a plotter, with a physical resolution of 0.002 inch (determined by the step size of its motor). An output resolution of 0.001 inch provides an image whose jaggedness is barely perceptible. On the other hand, if the database resolution is less than the plotter's, a circle looks like a many-sided polygon. If it is intelligent enough to draw a circle using a center and a radius, the plotter defines the resolution of the circle. With the pixel-based system, however, each pixel shows on the plotter as a line or dot, and the resolution is as crude as the one on the monitor.

A floating-point system permits a decimal rescale of virtually any proportion, while an integer-based system often permits rescaling the database image only in fractions of the database unit, such as ⅛, ¼, or ½. This potential limitation is a problem only if it hinders the drawing task at hand.

Zooming, Panning, Windows, and Views

Zooming in and out (see figure 4) fills the monitor screen with various views of the world coordinate system, both near and far—a very desirable software feature.

Zooming in creates a window that fills the monitor screen with a close-up of part of your drawing. The drawing resolution is coarser because an image that normally occupies ⅒ of the screen now occupies ½ of it with the same number of data points. The scale of the monitor image is different, but the world coordinate and grid systems remain the same. You can add more detail, and the input device appears capable of a higher resolution.

In an integer-based system where the input resolution matches the software coordinate system's resolution, if you zoom in on a 1- by 1-inch portion of the drawing, the resolution is 1000 by 1000 data points. There is no point in zooming in any further because you have already used the maximum resolution available.

To give you an idea of the magnification possible in a floating-point coordinate system with 1×10^{15} by 1×10^{15} resolution, you can zoom in from a view of a football field to an 8½- by 11-inch sheet of paper on the 50-yard line, read the writing on it, and then zoom further inside one of the letters on the page to do some detailed drawing.

Zooming out is the reverse of zooming in. After you zoom in on an area to do some detailed drawing,

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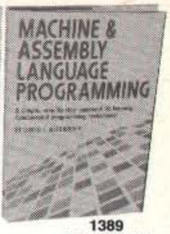

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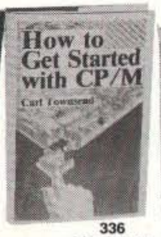

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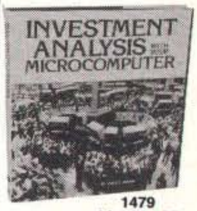

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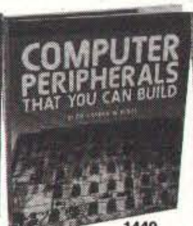

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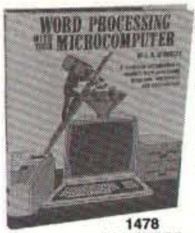

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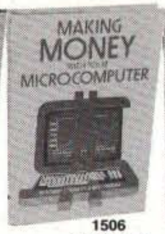

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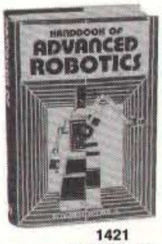

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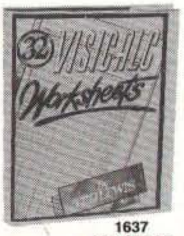

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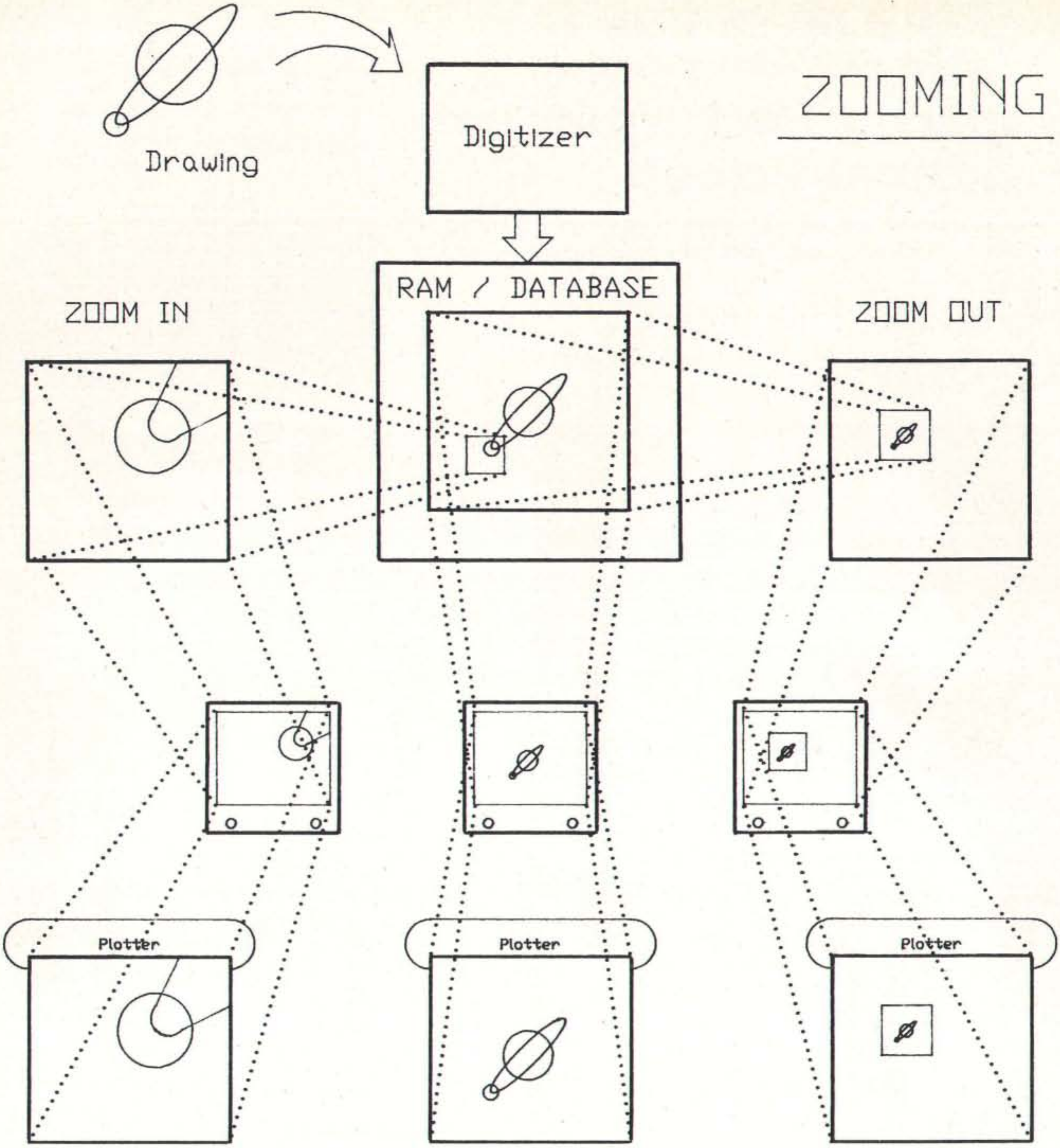

Figure 4: *Zooming, enlarging small parts of an image, changes the scale of the drawing in relation to the monitor.*

you zoom out to see the entire drawing again. With some software, you save these zooms, windows, or views to disk and call them back at any time.

Panning scrolls the zoomed-in window over the world coordinate system—wandering around the drawing. When you are doing detail work, it is easier to move to a new area than to zoom out and back in again.

How RAM and Disk Storage Are Used

The way a program utilizes RAM and disk storage is important. Figure 5 shows a block diagram of the interplay between RAM and storage.

Typically, the CAD software loads only the necessary program code into RAM, leaving Help files and a number of program overlays on disk until needed. These overhead items determine the workspace left to manipulate the world coordinate system and the resulting database. In general, the less RAM you have, the more overlays and disk I/O you need. In a CP/M system with 64K bytes, many overlays are needed to run such a large and powerful program.

What determines the maximum size of your drawing? A drawing is "RAM bound" if its size or the num-

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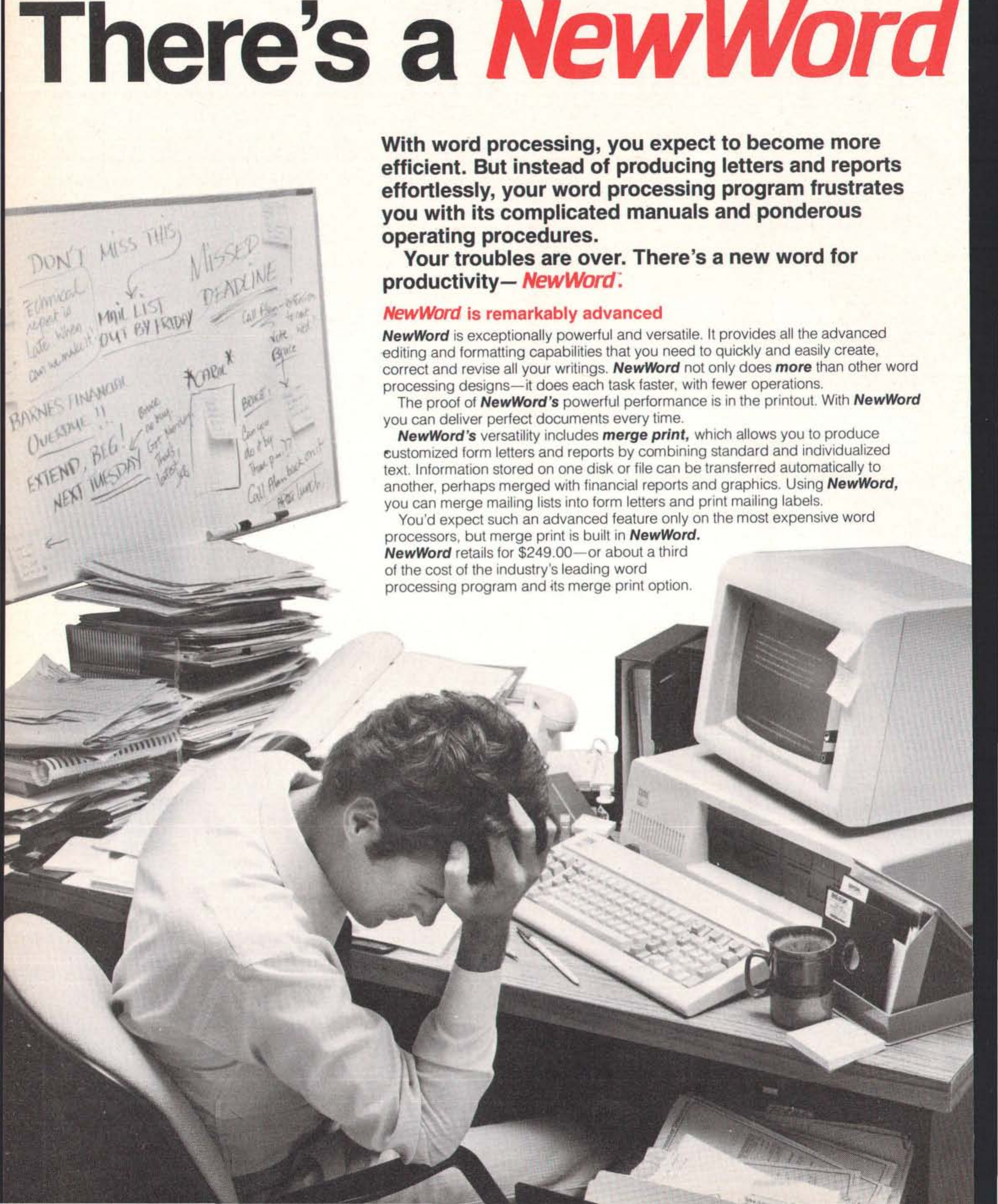

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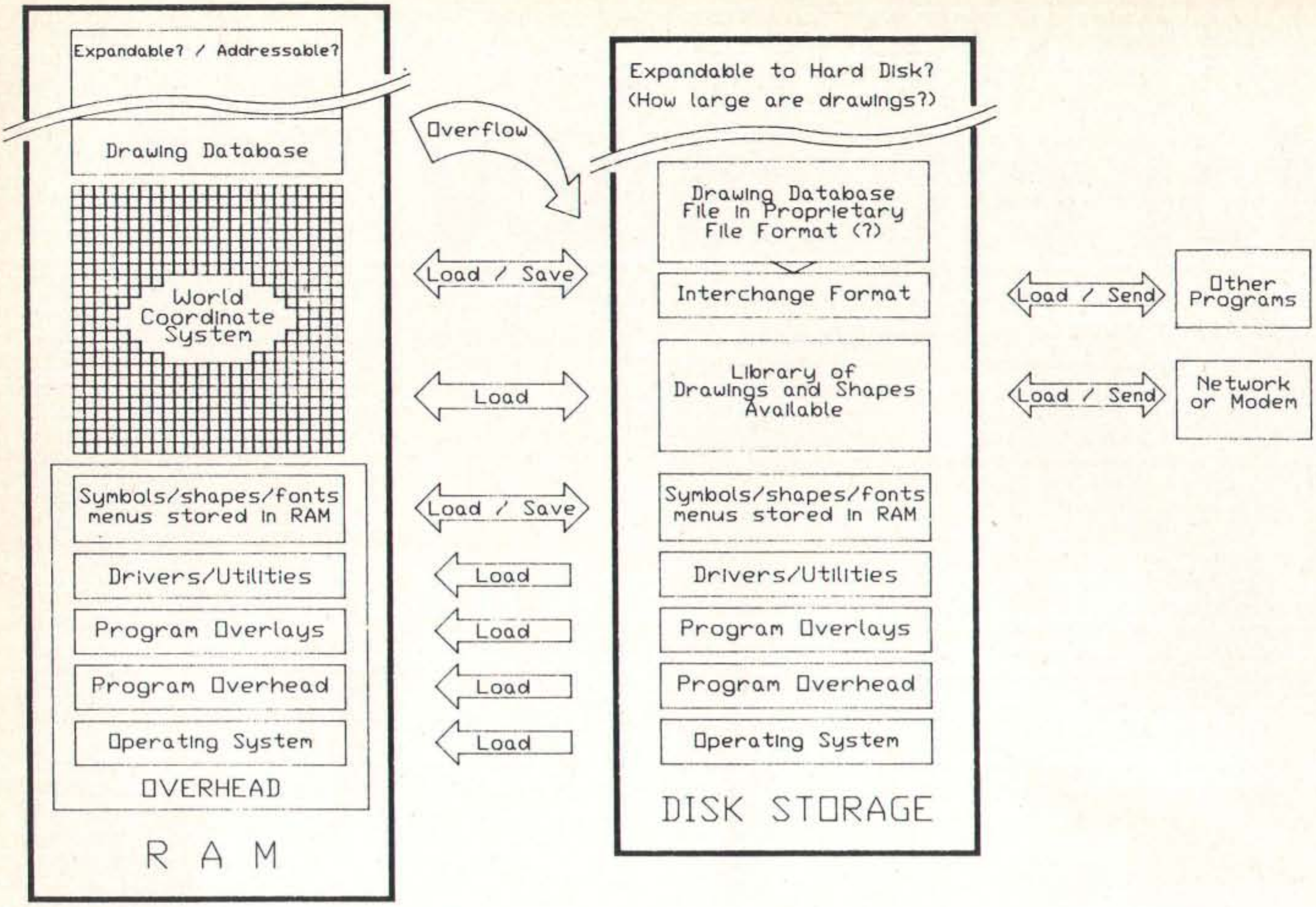

Figure 5: *The interplay between RAM and disk storage.*

Text continued from page 194:

ber of drawing entities you can place in it are limited by the RAM available or addressable. Some software packages (e.g., a pixel-based painting package) have a fixed coordinate system mapped out. Some software and hardware limit the amount of available RAM or determine the maximum amount of addressable RAM. Expandability and addressability are important features to consider.

When the size of your drawing reaches the hardware or software capacity, the system should give you a warning message rather than kick you out to the A> prompt. At the very least, you want an opportunity to save your work. Some software overflows the drawing database to disk (called paging), the same as a good word processor does. This allows your drawing to exceed the capacity of RAM.

If the software limits your drawing to a certain number of drawing elements, you are "element bound." For example, you might be limited to 3000 data points, vectors, vertices, or polygons or to 10,000 shapes, components, blocks, groups, or dictionary items.

If the software limits your drawing by the amount of disk storage available, you are "disk bound."

As attractive as a software package is, you must match the requirements of your typical drawings with these CAD limitations.

A truly powerful CAD configuration is capable of paging, uses a large number of drawing elements, and includes a large amount of hard-disk storage to minimize the risk of being disk bound. If you anticipate a significant amount of disk I/O, consider a hard-disk system. If your time is valuable and you expect to use your system a lot, make sure it is big enough to meet your drawing needs in terms of speed and capacity.

A Buyer's Guide

The list of features described in the table comparisons (tables 5, 6, and 7) is food for thought but is certainly not complete. When you go to buy your CAD package, ask pertinent questions and expect answers. At the very least, you will be referred to a more informed individual. This way, you begin the journey to a wise decision. Many vendors and program developers give demonstrations. Attend some if possible. If you can't take the time for all this, hire a good consultant. Here are some questions and features to consider.

The vendor's update policy is extremely important. This industry is changing so rapidly that products are in a constant state of evolution. How will the vendor notify you of program improvements or revisions? If you're a licensed owner, do you receive a newsletter or revision/update notification? Check it out.

What training or support does the vendor offer? Do you get support through an "800" number? Is the software portable? If you want to use your drawings on a variety of com-

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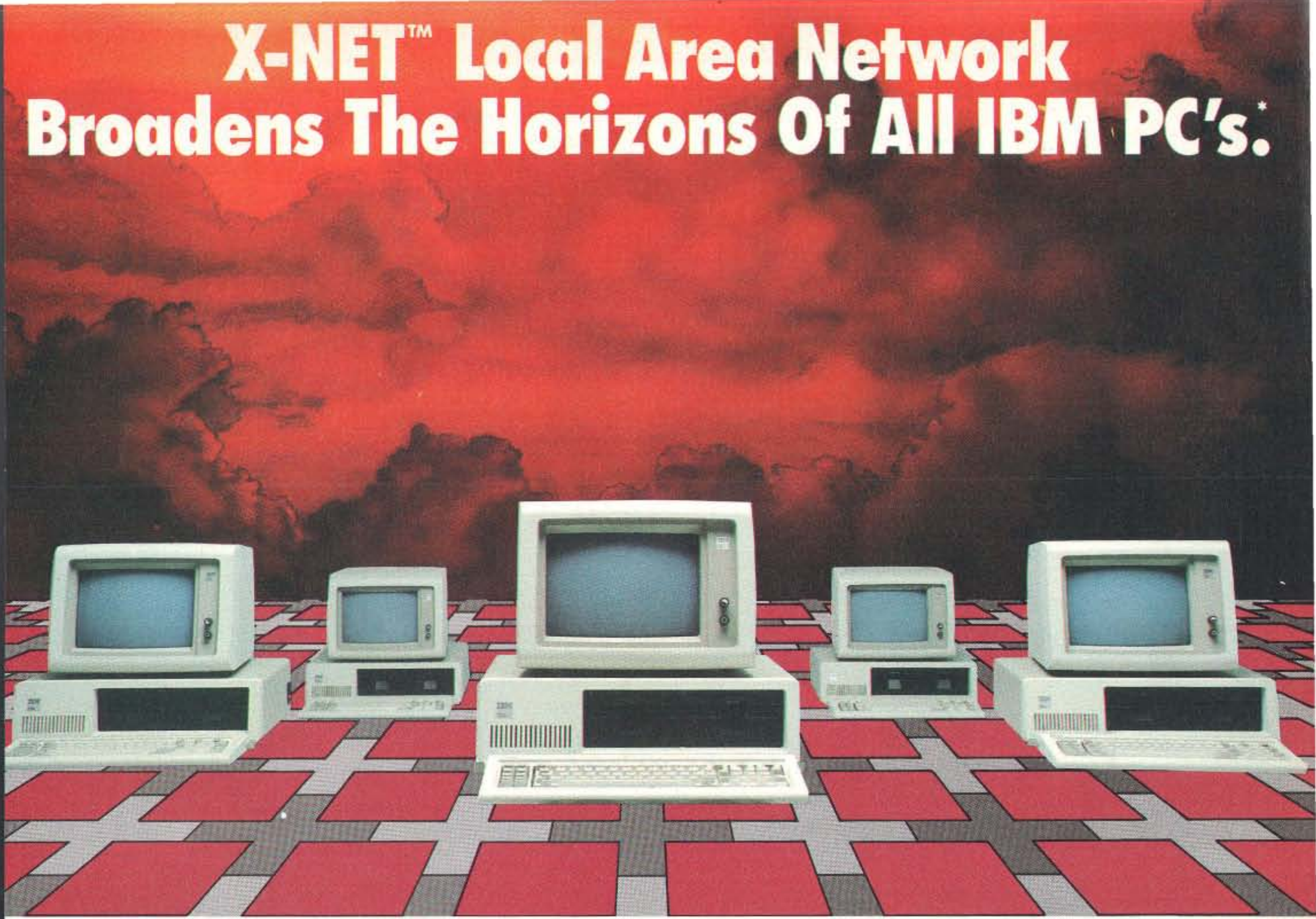

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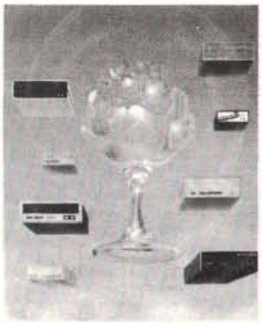
Circle 385 on inquiry card.

Primitive Features	PC-Draw	CADdraft	Benchmark	Vector Sketch	Drawing Processor	CADplan	AutoCAD	VersaCAD
Keyboard Data Entry								
All entries	•	•			•	•	•	•
Coordinate entry		•			•	•	•	•
Absolute coordinates		•			•	•	•	•
Relative coordinates		•				•	•	•
Polar coordinates							•	•
Color	12/83	•	1/84	1/84		•	•	•
Freehand draw	•	•	•	•		•	*	
Lines	•	•	•	•	•	•	•	•
Line types		•	•	•	•	•		•
Line weights/widths		•	•			•	•	•
Rubber-band lines		•	•	•	•	•	•	•
Arcs (2 pt. and center)		•	•	•	•	•	•	•
Arcs (3 pts.)		•	•		•	•	•	•
Arcs (angle specification)			•				•	•
Arc line weight		•				•		
Circle (radius and center)	•	•	•	•	•	•	•	•
Circle (diameter)			•				•	•
Circle (3 pts.)		•			•	•	•	•
Circle line weight		•				•		
Ellipse			•		•			•
Bezier curves			cubic spline					*
Curve smoothing			1/84		*			•
Fillets							•	•
Fill irregular shape	•	•	•		11/84	•	•	
Fill w/color	•	•	•		11/84	•	•	
Crosshatch					11/84		*	•
Fill/hatch user-definable			•		11/84		•	•
Fill/hatch part of database	•		•		11/84		•	
Text	•	•	•	•	•	•	•	•
Fonts supplied	•		•				•	•
Fonts user-definable	•		•		3/84		•	
Height scaling	•		1/84		•	•	•	•
Width scaling	•		1/84		•	•	•	•
Weight	•						•	
Rotation	•	•	1/84		•	•	•	•
Left justification	•	•	•	•	•	•	•	•
Right justification					1/84	•	•	4/84
Center justification					1/84	•	•	4/84
Word-processor mode	•		1/84			•	•	3/84

Table 5: *A comparison of primitive features.*

• = existing feature
* = outstanding feature
date = expected release date



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Editing Features	PC-Draw	CADdraft	Benchmark	Vector Sketch	Drawing Processor	CADplan	AutoCAD	VersaCAD
Edit Control								
Cursor style change					•	•	•	•
Coordinate dial	•	•		•		•	•	•
Status on screen	•	•		•		•	•	•
Status of item		•				•	•	•
Status report		•				•	•	•
Pan	•	•	•			•	•	•
Zoom by scaling		•		•	•	•	•	•
Zoom by window		•	•		•	•	•	•
Refresh (raster redraw)	•	•	•	•	•	•	•	•
Move item	•	•	•	•	•	•	•	•
Move group of items	•	•	•		•	•	•	•
Move by window		•			•	•	•	•
Move between layers		•	•			•	•	•
Move and rotate	•	•	1/84		•	•	•	•
Move and scale	•		•		•	•	•	•
Copy item/group of items	•	•	•	•		•	•	•
Copy from disk		•	•	•	•	•	•	•
Copy by window		•					•	•
Copy window to disk			•				•	*
Copy between layers			•					
Copy and rotate	•	•	•		•	•		
Copy and scale	•		•		•	•		
Identify an item		•	•			•	•	•
Erase item/group of items	•	•	•	•	•	•	•	•
Erase by window	•	•	•		•	•	•	•
Erase a layer		•	•			•		
Erase a shape	•	•	•	•	•	•	•	•
Erase previous/beyond previous		•	•	•	•	•	•	•
Restore last				•			•	•
Restore beyond last				•				•
Partial Delete of:								
Lines		•				•	*	•
Arcs							*	•
Circles							*	•
Ellipses								•
Solids								•
Rubber-banding windows						•	•	•
Naming of items							•	•
Shapes/groups/blocks	•	•	•	•	•	•	•	•
Multiple colors/ multiple layers	•	•				• •		• •
Explode							•	•
Nesting	•						•	•
Save to disk	•	•	•	•	•	•	•	•
Drawing libraries on disk	•	•	•	•	•	•	•	•
Merge with current drawing		•		•	•	•	•	•
Merge exploded							•	•
Merge and rotate/scale							•	•
Modify base point						•	•	•
Directory of disk files while in drawing editor	•	•		•		•	•	•

Table 6: *A comparison of editing features.*

• = existing feature
* = outstanding feature
date = expected release date

Text continued from page 198:

puters, the software needs to support them. If someone borrows your plotter and you want to attach a different one, is the software flexible enough to reconfigure on the fly?

Is the software language used by the package upwardly mobile? Does it have a file-structure option other than the drawing file format? In other words, can you communicate with other programs, or are you locked into this particular vendor? Do you receive a detailed description of the drawing file structure?

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Math Calculations								
Distance		•	1/84		•	•	•	•
Area			1/84		•	•	•	•
Area—irregular			1/84		•		•	•
Volume						•		
Angle			•		•			•
Feet and inches		•			•	•	•	•
Dimensioning								
Autodimensioning			1/84			•	•	•
Angular dimensioning						•		•
Associative dimensioning						•		
Miscellaneous								
Grid/user-definable grid	•	•	•	•	•	•	•	•
Different *x* and *y* scales		•	•			•		•
Grid snap	•	•		•	•	•	•	•
Multiple definitions	•	•	•	•	•	•	•	•
Auto change with rescale/zoom							•	
Tolerance/incremental snap	•	•		•	•	•	•	•
Layers		•	•			•	•	•
Mixed color on one layer		•	•			•	•	•
Define attributes of layer						•		•
Move between layers		•	•			•	•	•
Regenerate only active layers			•					•
Plot only active layers		•	•			•	•	•
Save only active layers			•					
Rectangular arrays						•	•	•
Radial arrays							•	•
Menu on screen in editor	•	•		•		•	•	12/84
Menu on input device			•		•		•	12/83
Menu user-definable	•		•		•		•	4/84
Command (macro) files in menu							•	6/84
Other command file use			•			•	•	•
Symbols on digitizer					•		•	•
Symbols (icons) on screen	*							
CAE utilities			•		•	•	•	
CAM utilities								•
Three-dimensional interface								•

Table 7: *A comparison of miscellaneous features.*

• = existing feature
* = outstanding feature
date = expected release date

mensely in taking you through the learning process. You want a well-organized manual, a good table of contents, a setup and hardware configuration section, a strong tutorial section, a full discussion of features with examples, a quick reference section, a section on error messages, a good index, and a glossary of terms. It is important to have a manual with illustrations from the CAD program itself.

Look for sample drawings or an interactive tutorial on disk and Help files accessible without having to leave the drawing editor. See that prompts are helpful and don't stand in the way of your drawing. It is convenient to have a directory of the files on the disk available from within the graphics editor as well.

The cost of hardware is falling, while quality and capability are on the increase.

Summary

I hope this whets your appetite for graphics. Graphics image processing offers an electronic frontier every bit as exciting to explore as it once was to migrate west to mine for gold.

CAD software is becoming more powerful and reasonably priced. The cost of hardware is falling dramatically, while quality and capability are on the increase. More power and capability are coming, but is all the work we do now translatable into the future?

It is difficult to draw conclusions about whether one software package is better than another. That decision is largely determined by your per-

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sonal preference and application. Take the time to make sure the software/hardware configuration you purchase is, or will be, equal to your drawing needs (see figure 6). Above all, ask the right questions and get satisfactory answers.■

Rik Jadrnicek is president of Micro Flow (POB 1147, Mill Valley, CA 94942), a microcomputer consulting firm. When he isn't writing or playing with micros, Rik likes sailing and traveling.

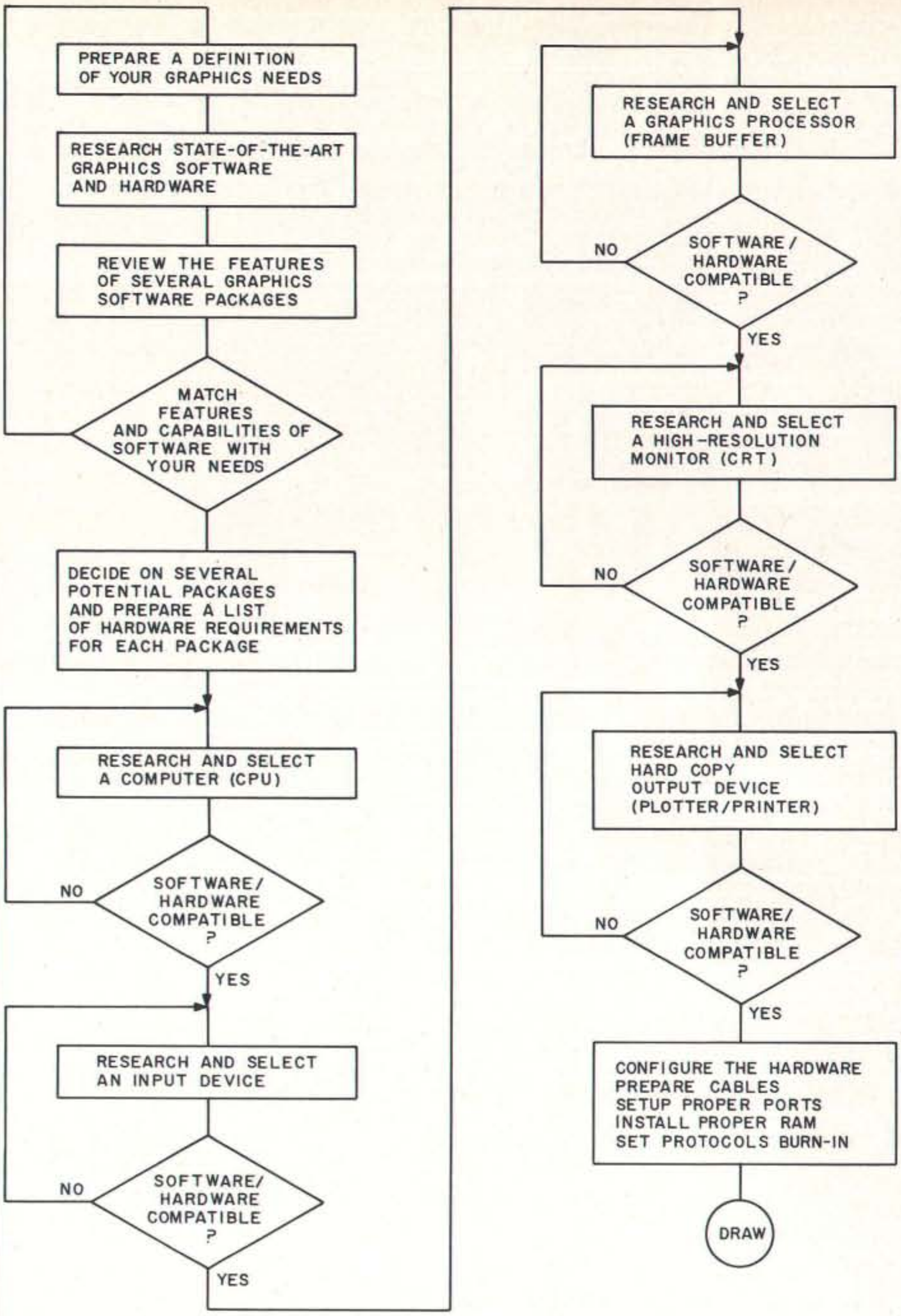
PREPARE A DEFINITION OF YOUR GRAPHICS NEEDS
RESEARCH STATE-OF-THE-ART GRAPHICS SOFTWARE AND HARDWARE
REVIEW THE FEATURES OF SEVERAL GRAPHICS SOFTWARE PACKAGES
MATCH FEATURES AND CAPABILITIES OF SOFTWARE WITH YOUR NEEDS
DECIDE ON SEVERAL POTENTIAL PACKAGES AND PREPARE A LIST OF HARDWARE REQUIREMENTS FOR EACH PACKAGE
RESEARCH AND SELECT A COMPUTER (CPU)
NO
SOFTWARE/ HARDWARE COMPATIBLE ?
YES
RESEARCH AND SELECT AN INPUT DEVICE
NO
SOFTWARE/ HARDWARE COMPATIBLE ?
YES
RESEARCH AND SELECT A GRAPHICS PROCESSOR (FRAME BUFFER)
NO
SOFTWARE / HARDWARE COMPATIBLE ?
YES
RESEARCH AND SELECT A HIGH-RESOLUTION MONITOR (CRT)
NO
SOFTWARE/ HARDWARE COMPATIBLE ?
YES
RESEARCH AND SELECT HARD COPY OUTPUT DEVICE (PLOTTER/PRINTER)
NO
SOFTWARE/ HARDWARE COMPATIBLE ?
YES
CONFIGURE THE HARDWARE PREPARE CABLES SETUP PROPER PORTS INSTALL PROPER RAM SET PROTOCOLS BURN-IN
DRAW

Figure 6: *How to buy a CAD system.*

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CAD/CAM Alert
The Management Roundtable Inc.
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Chestnut Hill, MA 02167
Published monthly

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Glossary of CAD Terms

absolute coordinates: *the location of a point in terms of x, y, or z distance from the predefined origin.*

absolute vector: *a line segment with an endpoint expressed in x, y, and z coordinates.*

aliasing: *the stairstep effect on a raster display lacking the resolution to reproduce diagonals or circles as smooth images.*

antialiasing: *the software adjustment of raster-pixel addressing to make diagonal or curved lines appear smooth and continuous.*

aspect ratio: *a design engineering term meaning the ratio of display width to display height.*

associative dimensioning: *updating dimensions of individual CAD/CAM display elements as display dimensions change.*

attribute: *any characteristic of a display item (color, line style, character font) or associated descriptor (style, shape, tolerance, part type or number).*

beam-penetration CRT: *this produces color by varying the electron-beam penetration of a multilayer phosphor display surface.*

Bezier curve: *a method of curve fitting (smoothing) by manipulating two line segments and the curves that are tangent to their surfaces.*

bit map: *the digital representation of an image in which bits are mapped to pixels. In color graphics, a different bit map is used for each red, green, and blue value.*

bit plane: *hardware used as a storage medium for a bit map.*

CAD: *computer-aided design, drawing with the aid of your computer.*

CAE: *computer-aided engineering, an interface with mathematical analysis and drawing capability.*

CAI: *computer-aided instruction, using computers for individual and classroom instruction.*

CAM: *computer-aided manufacturing, automated production.*

clipping, windowing, and viewing: *the process of setting graphics-display boundaries.*

composite color: *color information encoded in a single video signal.*

computer animation: *the use of computer graphics to simulate or generate images for motion pictures.*

control dial: *a graphics input device that produces a continuous range of display values.*

coordinates: *a number of x, y, and z units that give the location of a point in a coordinate system.*

cross hairs: *the cursor or two intersecting perpendicular lines on display to indicate coordinate location.*

device coordinate system: *the coordinate system and axis length recognized by the display device.*

device-independent CAD: *CAD software capable of running on more than one type of computer or input/output device.*

digitize: *to register a visual image or real object in a format that can be processed by the computer; data is read into the system with a puck, cursor pad, or stylus.*

dimensioning: *setting measurements on a CAD/CAM display; placement of dimension lines and arrowheads; calculation and placement of dimension distances.*

display: *a collection of graphics elements visible on the monitor.*

dot matrix: *a pattern of dots in a two-dimensional array.*

dot-matrix plotter: *a hard-copy device that reproduces the display as a pattern of dots.*

dragging: *leading an item, such as a user-defined cursor, across the display with a graphics input device.*

draw: *to generate a visible vector by moving a pen or by illuminating pixels between the current position and an endpoint specified in coordinates (absolute draw) or in displacements (relative draw).*

echo: *a graphics display, such as a text string or cursor, that provides visual feedback to the operator.*

electroacoustic tablet: *a data tablet with a writing surface of magnetostrictive material capable of tracking a stylus.*

electrostatic plotter: *a raster hard-copy device that produces images on paper sensitized to electrostatic charges.*

endpoint: *the end of a line segment expressed in terms of x, y, and z coordinates.*

fill: *solid coloring or shading of display surface made by a pattern of line segments.*

fillet: *a design engineering term meaning the concave transition surface between two otherwise intersecting surfaces.*

flatbed plotter: *a plotter with a flat display surface that you move across, up, down, and diagonally, with the plotting head.*

frame buffer: *local raster memory that stores the bit patterns mapped to pixels.*

function key: *the key on a function pad that triggers a programmable operation such as rotation or scaling.*

geometric model: *quantitative representation of a two- or three-dimensional object created by referring to the Cartesian coordinate grid.*

grid: *uniformly spaced intersecting lines in two or three dimensions, which provide addresses for graphics objects.*

hatching: *filling an area of the display surface with a regular pattern of line segments.*

icon: *a graphics symbol representing a menu item.*

image digitizer: *a video camera with an electron-beam scanner that senses light and transforms it into a video signal.*

imaging: *computer processing of graphics data to produce a display.*

incremental plotter: *a hard-copy output device that repeats a display at discrete intervals.*

incremental vector: *a repeated vector defined by a regularly increased or decreased component and an absolute component.*

ink-jet plotter: *a hard-copy plotter that uses electrostatics first to atomize ink, then to place droplets on the plotting medium.*

joystick: *a graphics input device that positions a cursor, locator, or pick or initiates a program change with a control lever.*

laser plotter: *this plotter uses a laser to produce images on photographic film in raster or vector format.*

layer: *logical two-dimensional CAD/CAM data divisions that can be viewed individually or as overlays.*

light pen: *the graphics input device used as a pick to identify a detectable display element.*

line style or type: *a primitive attribute that defines a line as solid or dashed and gives the dash pattern and terminators.*

line width or weight: *this primitive attribute defines a line's thickness.*

mapping: *transforming an image from one coordinate system to another.*

matrix: *an array of x, y, and z coefficients for calculating a geometric transformation.*

mirror: *to create the reverse image of a display item.*

mouse: *a hand-held input device used to position the cursor on the display surface.*

numerical control: *computer instructions that automate machine and drafting tools.*

origin: *the zero intersection of x, y, and z axes from which all points are calculated.*

orthographic projection: *graphics representation of a three-dimensional object lacking the perspective suggested by the convergence of parallel lines. It permits only vertical and horizontal line segments in a two-dimensional drawing.*

overlay: *the plane of a graphics display that can be superimposed on another plane.*

paging: *overflowing the drawing database to disk.*

painting: *a raster design technique based on illuminating pixels on a graphics display device.*

pan: *movement across the x and y grid.*

parallax: *apparent image translation from its initial location to the point indicated by a light pen.*

perspective projection: *simulation of depth and distance by representing parallel lines merging at a vanishing point.*

pixel: *the minimum raster display element represented as a point with a specified color or intensity level.*

pixel replication: *scaling by increasing the number of pixels excited, but without the increased detail of true magnification.*

plotter: *a computer-controlled pen device that produces a hard copy of the display on paper or an electrostatic surface.*

polar coordinates: *location of a point in terms of the distance and angle from another point.*

polygon fill: *coloring or cross-hatching of a closed, multisided, program-defined surface.*

primitive: *the basic display element: point, segment, alphanumeric character, or marker.*

primitive attribute: *a visual characteristic of an output primitive, such as character size, line style, or blink rate.*

puck: *a hand-held device with cross hairs used to input coordinate data.*

RGB color: *a color described in terms of its red, green, and blue intensity levels.*

RS-232: *this serial interface permits linkage of a host computer and graphics terminal(s) or other peripherals over long distances.*

raster: *a rectangular pixel matrix permitting dynamic color displays.*

raster display: *a CRT display generated by an electron beam that illuminates.*

raster plotter: *this plotter reproduces displays in dot-matrix patterns.*

relative coordinates: *location of a point relative to another data point.*

relative draw: *movement of the electron beam in terms of x, y, and z distances for the purpose of drawing a visible vector on the display surface.*

relative move: *electron-beam movement in terms of x, y, and z distances without leaving a visible trace on the display.*

relative vector: *a vector with an endpoint specified in terms of the distance from the current position rather than in terms of absolute x, y, and z coordinates.*

rotate: *to transform a display or display item by revolving it around a specified axis or center point.*

rubber banding: *attaching the cursor to a fixed display point with a line that appears to stretch and contract like a rubber band as you move the cursor.*

SIGGRAPH: *Special Interest Group on Computer Graphics.*

scale: *a size change made by multiplying or dividing the coordinate dimensions.*

scale factor: *the value by which you divide or multiply the display dimensions in a scaling operation.*

screen coordinate system: *the coordinate system of the display device; normally, the address limits of the axis length it recognizes.*

scrolling: *moving text strings or graphics vertically.*

stairstepping: *jagged raster representation of diagonals or curves; corrected by antialiasing.*

static attribute: *an unchangeable display characteristic of the input device.*

tablet: *a data tablet or digitizer; a graphics input device that generates coordinate data from visual data input through a puck or stylus.*

touch-sensitive display: *a display surface that receives data through physical contact.*

trace: *a line of the graphics display.*

trackball: *this mounted rotatable ball controls the position of the cursor and produces coordinate data.*

transformation: *geometric alteration of a graphics display, such as scaling, translation, or rotation.*

translate: *to shift a display item across the display surface to a new location.*

turnkey: *a computer system sold complete and ready to use for a specific application; requires no additional hardware modification or planning.*

viewport: *the specified window on the display surface that marks the limits of a display.*

virtual coordinate system: *coordinate system created by mapping a portion of the world coordinate system to the space available on your device.*

virtual space: *space referenced with the coordinates defined by the application.*

window: *a specified rectangular area of virtual space shown on the display.*

window clipping: *blanking line segments at window boundaries.*

wire frame: *a three-dimensional image displayed as a series of line segments outlining its surface.*

world coordinate system: *a device-independent coordinate system used to define display objects.*

zoom: *to scale a display or display item so it is magnified or reduced on the screen.*

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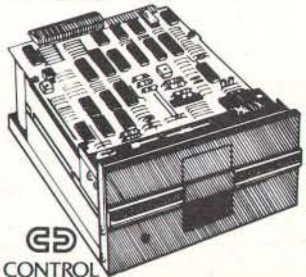

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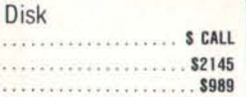

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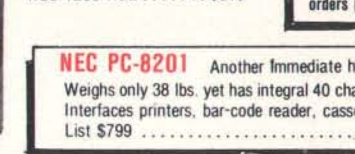

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Speech Recognition: An Idea Whose Time Is Coming

Some theoretical and practical aspects of this emerging technology

by George M. White

Someday machines that recognize speech will be commonplace. People will talk to computers, typewriters, toys, TV sets, household appliances, automobile controls, door locks, and wristwatches. Each of these speech-recognition applications is currently being explored; some early forms are already on the market, while other forms are proving to be beyond our current capabilities. In this article, I'll examine some of the theory and market prospects for this exciting and elusive technology.

Having our lives filled with machines that obey verbal commands can transform our views of machines. Mechanical devices can take on a subtle lifelike quality when given the ability to respond to speech. This lifelike quality is further amplified when coupled with the machine intelligence that emanates from personal computers, arcade games, robotics, and household automation systems. We continue to be fascinated by the evolution of such intelligent products, and we probably could not reverse this trend, even as visionaries warn that we'll lose our freedom to new mechanical life forms.

Automatic speech recognition is generally considered to be the most difficult and complex problem in the field of voice processing. Voice synthesis, compression, analysis, encryption, and transmission are all more narrowly defined, and all contribute to the solution of the speech-recognition problem. Some of the world's largest companies (AT&T, IBM, Exxon), the U.S. Department of Defense, and several universities have been developing speech-recognition technology for years without the hoped-for degree of success. But despite difficulties, steady progress is being made.

In the past 10 years, at least a dozen start-up companies have been founded explicitly to develop and market speech-recognition products. Although several have gone out of business, about a dozen companies plan to be in the market with new products in 1984.

Philosophical Issues

The specter of Big Brother may not be of concern in Western society today, but the evolution of distributed intelligence among machines with speech-recognition capability certainly provides the technical base for monitoring our activities. In fact, the U.S. National Security Agency has developed what may be the world's most advanced speech-recognition algorithms. This system spots keywords in intercepted verbal transmissions from "unfriendly" nations. Currently, it is not likely that such techniques would be used for domestic surveillance. But speech technologists as well as the public must be aware of the potential loss of privacy.

Speech recognition is not a typical engineering problem. It is a scientific Gordian knot. It draws on LSI (large-scale integration) and VLSI (very large-scale integration) chip design, signal processing, acoustic-phonetics, natural-language theory, linguistics, mathematics of stochastic (probability) processes, and computer science techniques. Because of its multidisciplinary nature and because many competent minds have pondered the problem for years, we should not expect a breakthrough in speech-recognition capability. Progress will be made, but it will be evolutionary, not revolutionary. Naive enthusiasm from novices in the field sometimes leads to proclamations that dramatic progress is imminent. Such views fail to consider the interdependence of disciplines required to produce a commercially viable product.

Nearly 15 years ago, a number of

companies and engineering organizations predicted near-term success in speech recognition. This prompted a prominent scientific leader, John Pierce, to say that automatic speech recognition was the domain of "untrustworthy engineers" (see reference 8) and that we would not have speech recognition until we had true artificial intelligence (AI).

Pierce based his critique on the observation that normal speech contains many words that are acoustically ambiguous, and it is only through contextual information and knowledge of linguistic constraints that we are able to remove the ambiguity. Because only humans have demonstrated sufficient understanding of the language constructs of spoken sentences to use them in a way that is unambiguous, Pierce's conclusion that fluent speech recognition requires human-like intelligence is understandable.

Today we do have elemental speech-recognition systems that recognize short utterances. However, this does not nullify Pierce's argument; it is a matter of the type of speech to be recognized. When fluent conversational speech is involved, a "model of the domain of discourse" must be employed, and the recognition process is called "understanding." This is, by definition, in the domain of AI. Recognition of short utterances using only template pattern-matching techniques is, in current vernacular, "pattern recognition," not "understanding."

In a broader sense, even the simplest forms of speech recognition are a part of AI, and AI is spread out in the technologies that make up modern society. The maturation of speech recognition and AI has not been by intellectual tour de force but by a broad-based industrial/technical evolution. Key events in this evolution include the appearance of the mass market for home computers, VLSI, mass-production techniques, and, perhaps, even Pac-Man. Although these are not usually thought of in the same context as machine intelligence and speech recognition, they play a significant role in the development of such capabilities, and they cannot be ignored by forecasters and planners who hope to tell us what products will materialize in the next few years.

Success is slowly materializing. Today we have adequate machine intelligence to achieve elemental automatic speech recognition (ASR), but we are a long way from conversational speech understanding.

Definition of Terms

Automatic speech recognition means different things in different contexts. Speech-recognition products have been on the market for nearly 15 years for isolated utterances. "Isolated utterances" refers to words or short phrases spoken with pauses between them. "Continuous speech" refers to normal speech without pauses between individual words. ASR systems differ vastly in technical content, depending on the type of speech input expected.

Automatic speech recognition is the most difficult step in the voice-processing field.

For isolated-utterance input, a variety of signal-processing algorithms and classification schemes have been applied with success. In general, the more care and control exercised on speech input, the greater the number of algorithms that work, because there is greater redundancy in the acoustic input. To reduce costs, some speech-recognition device manufacturers specify that speech input is expected to be carefully enunciated, isolated utterances, in a noise-free environment, from a limited vocabulary, and from a "known" talker. A known talker is one whose voice characteristics have been previously analyzed and recorded. Of the many techniques employed, few have achieved a useful trade-off in cost versus resilience to imperfect speech input.

The technology required for transcription of general conversational speech far exceeds our current capabilities. Cost-effective, voice-controlled typewriters that accept normal speech will almost certainly not be on the market this decade.

The striking difference in technical content in speech-recognition systems has to do with contextual properties of speech that at first seem paradoxical. For example, typically 20 to 30 percent of the words from tape-recorded conversations cannot be understood when the words are played back individually in random order even though every word was perfectly understood in the original conversation (see reference 9). Thus, a word pronounced in conversation does not really carry the information we normally think it does. The information is spread out over several words rather than being encoded in individual phonemes (a member of the set of smallest units of speech), syllables, or words. The critical information needed to interpret a spoken word is not found in the word itself perhaps 30 percent of the time.

The information required to recognize a word in the context of normal speech floats on the "ether" of an entire phrase or sentence. Until we have intelligent machines that successfully extract semantic, syntactic, prosodic (stress), and perhaps pragmatic information from acoustic waveforms, we will not have conversational speech recognition by machines. It is safe to assume that this will not occur for several more decades. But there are other forms of speech that are easier for machines to recognize.

Carefully pronounced isolated-word utterances contain all the information needed for a machine to correctly recognize them without resorting to AI techniques. The technical barriers are more computational than theoretical, and, in fact, the more carefully pronounced the word, the less the computational power required. For a careful, cooperative talker in a low-noise environment, the computational power of the microprocessors in many personal computers is sufficient. But more computational power is required for multiple talkers, telephone input, larger vocabularies, word spotting, or connected speech recognition.

For example, speaker-independent recognition over telephone lines is difficult because telephones distort speech spectra in a variety of ways. The voices of unknown talkers will probably have a variety of different spectral shapes for the same speech sound. Techniques for solving these technical problems are known, but they are expensive: Verbex, a subsidiary of Exxon, has offered commercial equipment containing special-purpose, high-speed computers that sell for more than $65,000 to recognize digits and a few command words over dial-up telephones for arbitrary talkers.

The Cost Barrier

Widespread use of Verbex-type speech-recognition systems awaits dramatic cost reductions. In fact, the single greatest problem facing the entire field is the high cost of robust recognition capability.

Significant cost reductions can be achieved in at least four ways: through large-volume manufacturing (economies of scale), faster computers, advances in LSI and custom LSI, and algorithm enhancements. Activities of many leading firms can be characterized by their relative emphasis on these approaches. These firms will be covered in more detail later.

Only low-cost systems can currently reap the benefits of large-volume manufacturing; they can exploit the installed base of telephones, personal computers, and toys. Milton Bradley has pioneered a computer peripheral compatible with the TI-99/4A home computer that allows you to play games using oral commands. Interstate Electronics has developed a single-chip recognizer that could become widely used in a mass-produced vechicle, e.g., a toy. Verbex has developed a bit-slice machine architecture to carry out signal processing and pattern matching in its speech systems. Nippon Electric, Interstate Electronics, Threshold Technology, and Votan have developed special LSI chips for speech recognition. Several others, including Intel, Harris, American Micro Systems, and General Instruments, have developed general voice-processing chips. Every firm in ASR has emphasis on algorithms, but Dragon Systems of West Newton, Massachusetts, stands out for extraordinary achievement and focus on algorithms.

Algorithms Cut Costs

Algorithm improvements aimed specifically at cost reduction typically involve search strategies to reduce the number of paths that must be searched in decision networks. This results in an apparent increase in the execution speed of the computer. Execution-speed enhancements may be obtained not only by efficient search strategies but also by "precomputing" relationship networks that might otherwise require random, or "exhaustive," search techniques.

Dragon Systems has made progress in reducing computation through algorithm improvements. Dragon's speech-recognition system executes on an Apple computer and

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achieves recognition accuracies comparable to those executing on $15,000 machines without Dragon algorithms. The Dragon system basically consists of an 8-bit A/D (analog-to-digital) converter board and software.

How Speech Recognizers Work

Automatic speech recognizers are composed of sound *analyzers* followed by word *classifiers*. Sound analyzers may be nothing more than microphones followed by A/D converters (as in the Dragon system). More likely, the sound analyzer also performs bandpass filtering before A/D conversion. Most successful recognizers use bandpass filtering as the first step in analyzing an utterance. The most elementary and widely used approach to utterance classification is to form a two-dimensional matrix of the utterance with time along one axis and frequency energy content along the other. Reference matrices, which are generated for each word during talker training, are compared to the matrix of unknown utterances. The comparison is typically achieved by computing the distance (e.g., the sum of the square of the differences) between corresponding matrix elements in reference and unknown matrices for all elements in the matrices.

Dynamic Programming

There is an alternative to the matrix-comparison technique of classifying utterances known as "dynamic programming." Dynamic programming has been known to be superior for about 10 years. But consumer-oriented commercial systems avoid dynamic programming partially because of the large associated computational requirements and partially from lack of understanding of the algorithm.

Dynamic programming offers not only superior isolated-utterance recognition, but it also opens up the possibility of continuous-speech recognition. It has been more successful in continuous-speech recognition than any other algorithm, and it is used in the world's only commercial continuous-speech recognition systems.

The dynamic programming process computes many more combinations of time alignments between reference and unknown utterances than the static-matrix match just mentioned. In fact, its straightforward application increases the computation burden by a factor of 100. However, efficient search-path pruning algorithms can potentially (on the average) reduce the computational burden to the level required for matrix comparison. Recent cost reductions in commercial continuous-speech systems have cut costs by factors of two to five, and these cost savings are due directly to improved search strategies for dynamic programming.

One of the first steps in classifying an utterance is to convert it to a string of "phone units" (elementary sound units). This can be achieved by sampling the speech at a constant rate, e.g., 100 times a second. Alternatively, the speech is segmented into syllable-sized units by monitoring changes in energy or spectral content.

The problem with these approaches is that the number of time intervals or number of syllable segments usually varies from utterance to utterance. Talkers do not reliably reproduce segment durations or pronounce all the syllables in words. (Even if words were pronounced reliably, speech systems could not reliably segment the speech without simultaneously classifying the segment.) Therefore, the problem of variability in number of segments is inherent, and any successful classification scheme must deal with this variability. Dynamic programming provides an approach to handling this variability.

For example, suppose that the utterance "six" is segmented by a scheme that produces six segments: "ssiixs." Furthermore, suppose the correct reference template is "ssixxss." Dynamic programming determines how to "time-align" the segments of reference and the unknown utterances.

The first step is to measure the speech sound similarity between all segments in the unknown and all

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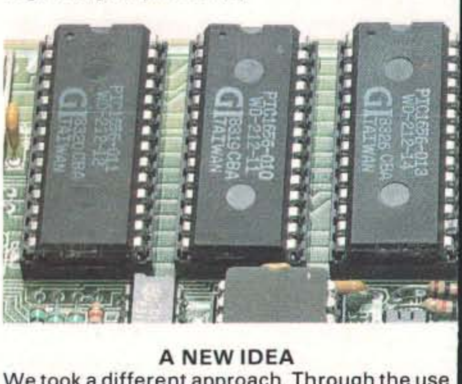

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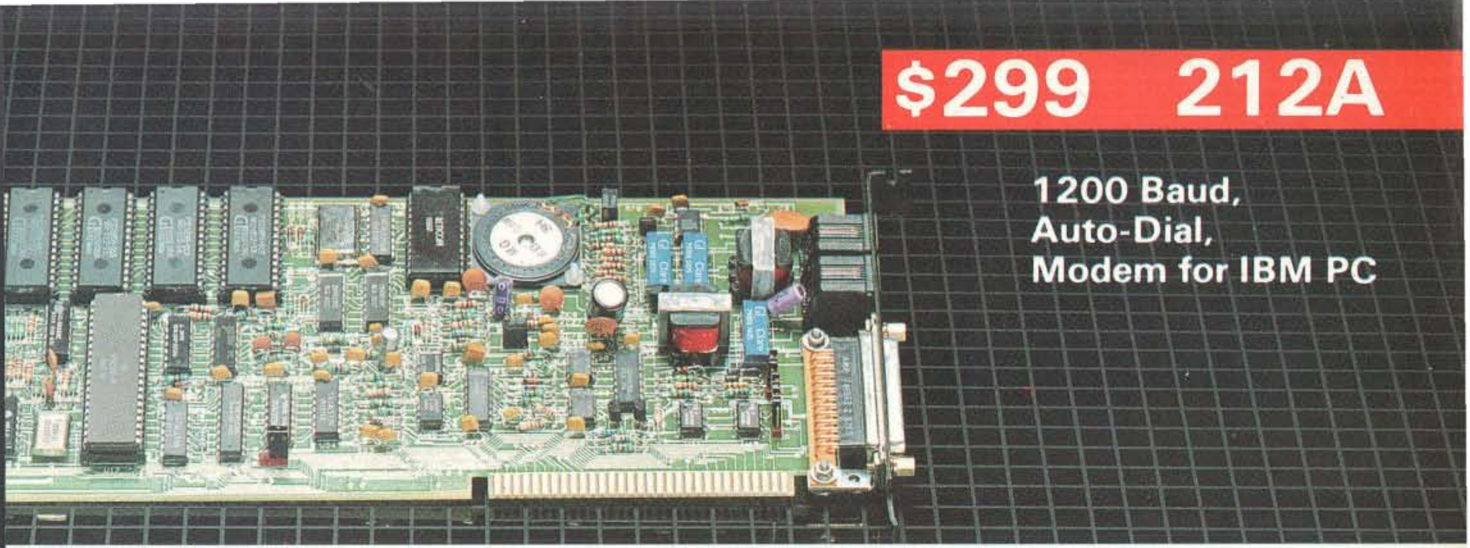

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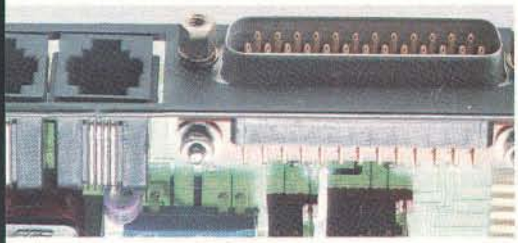

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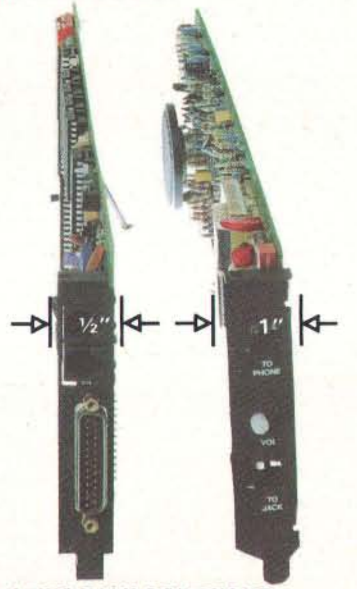

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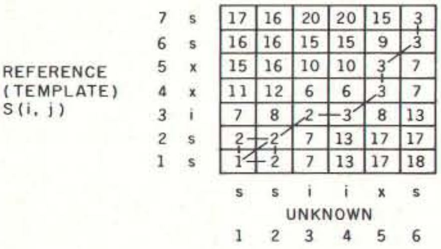
	6	s	1	1	5	5	6	0
	5	x	4	5	4	4	0	4
	4	x	5	6	0	1	5	5
	3	i	5	6	0	1	5	5
	2	s	1	1	5	6	4	1
	1	s	1	1	5	6	4	1
			s	s	i	i	x	s
		UNKNOWN						
			1	2	3	4	5	6

Figure 1: *A speech-sound similarity matrix, Q(i,j), containing scores for comparing sounds in reference and unknown utterances.*



REFERENCE (TEMPLATE) S(i, j)	7	s	17	16	20	20	15	3
	6	s	16	16	15	15	9	3
	5	x	15	16	10	10	3	7
	4	x	11	12	6	6	3	7
	3	i	7	8	2	3	8	13
	2	s	2	2	7	13	17	17
	1	s	1	2	7	13	17	18
			s	s	i	i	x	s
		UNKNOWN						
			1	2	3	4	5	6

Figure 2: *A dynamic programming matrix, S(i,j), containing the accumulated scores beginning at S(1,1) and ending at S(i,j). The lines connecting matrix entries show the optimal path linking segments in unknown and reference.*

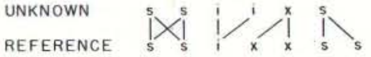


Figure 3: *The time alignment of unknown and reference utterances.*

segments in the reference utterance. The results are entered into a speech-sound similarity matrix shown in figure 1.

The problem can now be restated as follows: what is the path from the lower left-hand corner to the upper right-hand corner that produces the lowest value? The allowable paths can be constructed from horizontal, vertical, or diagonal moves. The dynamic programming solution is to evaluate S(7,6), where

$$S(i,j) = Q(i,j) + \mathrm{MIN}\ [S(i-1,j), S(i,j-1), S(i-1,j-1)]$$

Note that to evaluate S(7,6), other values of S must be computed first. So we begin with $S(1,1) = Q(1,1)$; and then $S(1,2) = Q(1,2) + S(1,1)$; $S(1,3) = Q(1,3) + S(1,2)$; etc., until the first row of an S(i,j) matrix is computed. Then we move to the second row, $S(2,1) = Q(2,1) + S(1,1)$. The previous computations were simple because there was only one way to move from S(1,1). But now, for the first time, S(i,j) location can be reached from more than one precursor, namely S(2,2) can be reached from S(1,1) or S(2,1) or S(1,2). Therefore,

$$S(2,2) = Q(2,2) + \mathrm{MIN}\ [S(1,1), S(1,2), S(2,1)]$$

In this example, $S(2,2) = 2$. The completed matrix is shown in figure 2. Note that the overall score for the match is 3, $[S(7,6) = 3]$. The optimal time alignment is shown by the lines in figure 2. The lines are put in as a final step, backtracking from S(7,6) to S(1,1).

The time alignment indicated by the lines is illustrated in figure 3.

This same approach can be used in "word spotting." In this application, the beginnings and endings of words are unknown. The matrices Q(i,j) and S(i,j) become longer, as long as an entire sentence. The top row of the matrix S(i,j) is monitored for a dip in scores. If a dip occurs, the word has been "spotted," or identified. Note that in figure 2 the scores along the top row are high until the last two entries [5(7,6)] are reached. If the matrix were extended to the right (because there were other words rather than silence), then the scores for the top row would become large again. Yet the matrix would reveal that "six" had been spotted because the scores would have dipped briefly from an average of approximately 18 to 3.

Dynamic programming and related mathematical optimization techniques are of exceptional significance to automatic speech recognition. More than any other single intellectual tool, it has enabled speech classifiers to progress beyond short simple words to handle longer words, phrases, and sentences. Dynamic programming was independently developed with minor variations in at least three different fields: operations research, communications theory, and in mathematics as a first-order Markov process (see references 2, 3, and 12). None of these original formulations was for speech applications.

What's Available Now?

Table 1 shows the product names and identifies the manufacturers of products on the market in 1983 that are expected to be available in 1984. Note that these products are not intended for consumers but, rather, for industrial applications. The industrial applications are typically "hands-busy" activities involving inspections usually associated with quality control (for example, on an assembly line or in a laboratory in conjunction with entering data gathered using microscopes). The variety of applications is extraordinary, although the number of applications appears small. Other examples include flight-training simulators for entering a limited set of command words, baggage/parcel sorting, voice control of machine tooling, and home-appliance control by personal computers. They have occasionally been used for educational applications.

Connected speech recognition is essential for some applications such as zip-code reading for parcel sorting by the United States Postal Service. Note that there are only three manufacturers of continuous speech systems.

It appears that the exciting new developments to watch in 1984 will come from Nippon Electric Corporation (NEC), Dragon Systems, Voice Control Systems, Interstate Electronics, and possibly Asulab. NEC is exciting for two reasons: first, the company has an extraordinarily good continuous-speech recognition system for vocabularies of up to 120 words for users who have trained the system (around $2000); and second, NEC's lower-performance three-chip set will soon be available, recognizing 128 words of isolated utterances for talkers who have trained the system (estimated at $35 per chip set in large quantities). This chip set, available on an OEM (original equipment manufacturer) basis to American manufacturers, should make speech-recognition technology widely available for isolated utterances.

Dragon Systems has developed al-

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Interstate	VRT 300	$1100	Isolated word	No	80
Nippon Electric Corporation (NEC)	SR 100	$2000	Continuous speech	No	120
Votan	V 5000-A	$6000	Isolated word	No	256
Interstate	VRT 101/3/11	$5000	Isolated word	No	80
NEC	DP 200	$15,000	Continuous speech	No	150
Verbex	3000	$20,000	Continuous speech	No	120
NEC	SR 1000	$60,000 (variable)	Isolated word	Yes	20

Table 1: *The commercial speech-recognition products suitable for industrial use. Note that continuous speech and speaker independence correlate with higher cost. The prices and vocabulary sizes of systems are rounded to fall into general groupings.*

gorithms that it is prepared to license. The company's work represents a breakthrough in algorithm development, which has major implications for the entire field. These algorithms could enable the world's most cost-effective speech-recognition devices to be developed. They have demonstrated performance superior to systems costing over $15,000.

Voice Control Systems (VCS) has developed a time-domain, low-cost (requiring an 8-bit microprocessor such as a 6502), speaker-independent recognition scheme that it is licensing for a modest fee. This system is potentially less expensive than those of NEC or Dragon, but its vocabulary is limited to only 10 to 20 words at a time. On the other hand, the speaker independence of the VCS system makes it much more appealing as a consumer product, which ultimately may open possibilities for cost reduction and development of additional applications.

Finally, Asulab, of Neuchatel, Switzerland, is developing a wristwatch speech-recognition device. This will be an extraordinary technological achievement as well as an interesting consumer device. The system will be speaker-dependent (that is, it must be trained before use) and is capable of recognizing only 15 words spoken in isolation. It will be used to set the time, alarm, stopwatch function, and other standard timepiece operations.

Interstate Electronics Corporation, the oldest and probably one of the most successful speech-recognition companies in the United States, has produced a speech-recognition chip that enables speaker-independent isolated utterances suitable for consumer products, including toys. After an initial tooling charge, quantities of 100,000 or more cost $5.50 per chip. This system enjoys an 85 to 90 percent accuracy level and is capable of recognizing a 16-word vocabulary.

Summary

Automatic speech recognition is an old idea that has fascinated researchers for a quarter of a century and frustrated attempts at commercialization for 15 years. During these years, important progress has been made in pattern matching through dynamic programming, in cost reduction through LSI (and VLSI) chips, and in voice processing through signal-processing theory and VLSI. Commercial potential is finally becoming realizable.

The concept of talking to machines instead of keystroking input has considerable appeal to the buying public. Market forces will prevail, and, I believe, speech-recognition products will literally invade our lives within a decade or two. In the near term we will see speech-recognition peripherals for computers, later as consumer novelties (such as voice-controlled watch/calculators), and eventually as telephone controller/

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dialers and voice-actuated typewriters. In the broader sense, speech recognition is part of the general evolution of machine intelligence. It depends on the same fundamental technology as AI and provides the link that will bring us closer to our bright new machines.■

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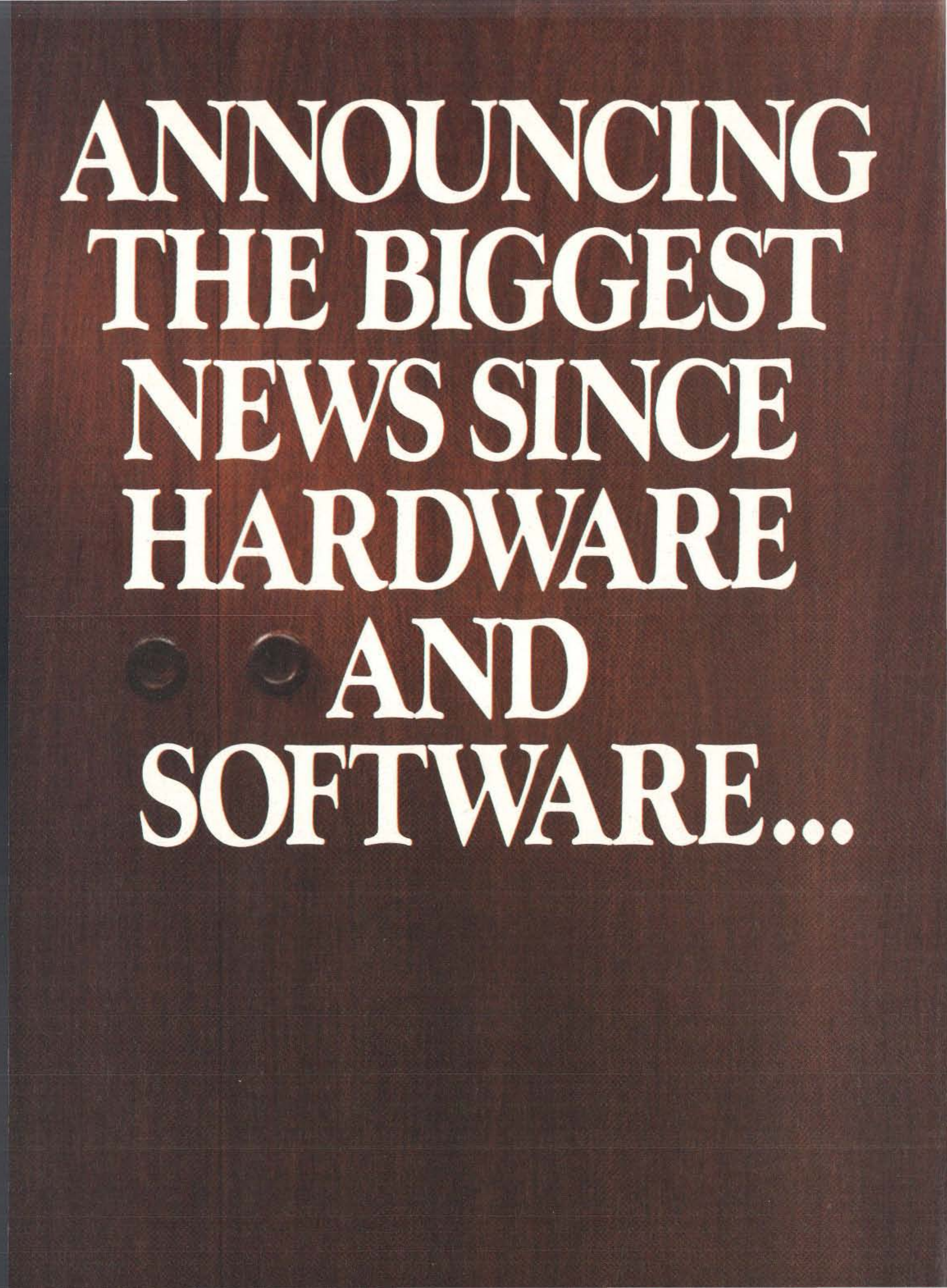
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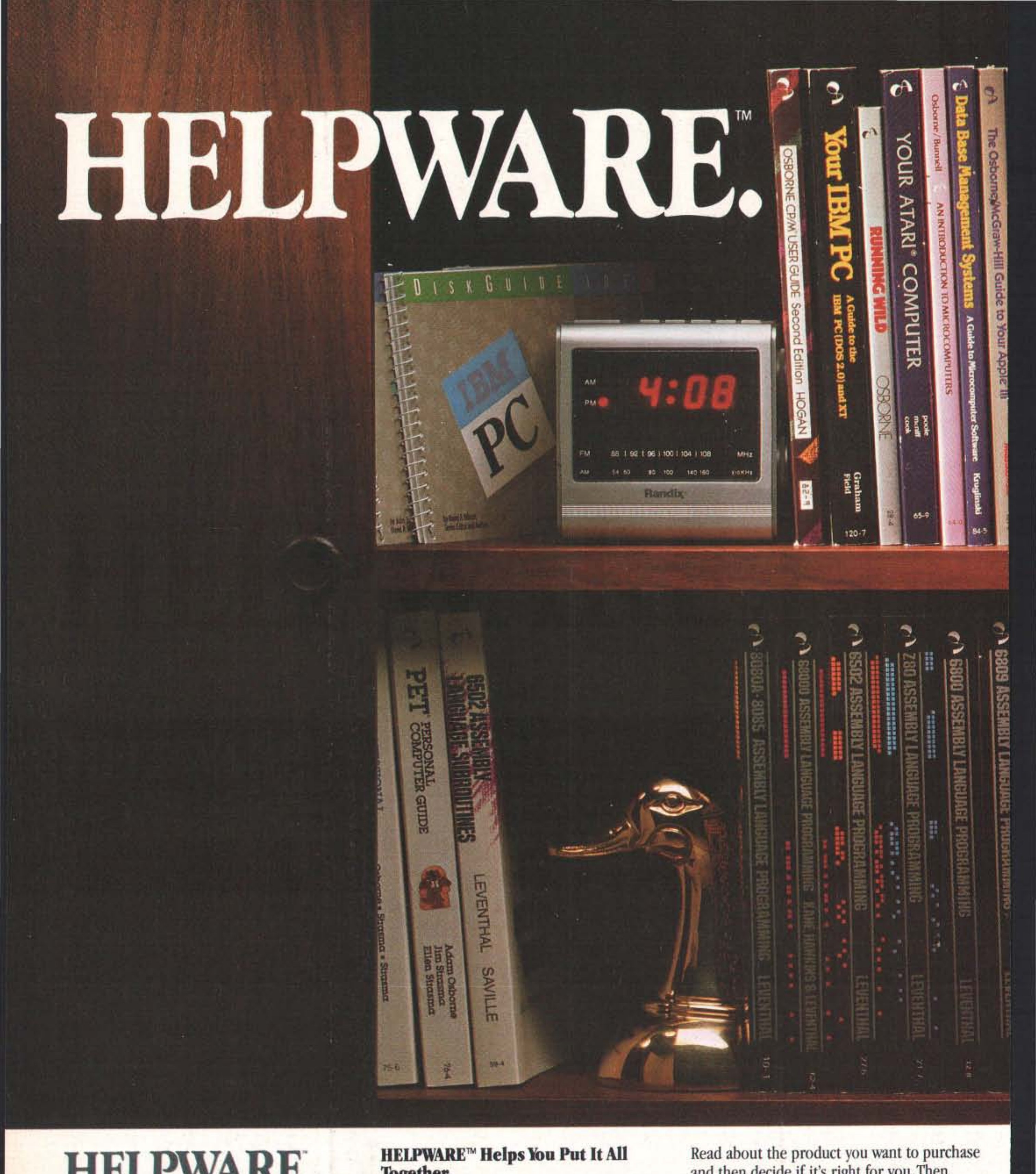
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Using Natural-Language Systems on Personal Computers

Your computer may speak English in 1984

by Jane Eisenberg and Jeffrey Hill

In boardrooms, managers' offices, secretarial pools, and hallways of corporate America, the role of computer technology is being reexamined. With the advent of personal computers, people no longer stand in awe of the machines or accept that the high priests of data processing must always intercede in the everyday use of the technology by knowledge workers.

A common refrain in these enclaves is, "Will computers ever understand English?" Indeed, the promise of the "computer revolution" seems to hinge on the machine's ability to speak the language of people, not the reverse. In George Orwell's *1984*, if you remember, the computer-controlled apparatus of Big Brother had mastered the skill; in fact, it understood everyday conversation all too well.

The little-understood field of Artificial Intelligence (AI) may be the key to the eventual scaling of the human-computer communication hurdle. AI researchers avow that natural-language query systems are an economically approachable reality in the year ahead.

In the following pages, we'll discuss some of the ways in which natural-language query systems will change the way that people and personal computers interact.

What Is a Natural-Language System?

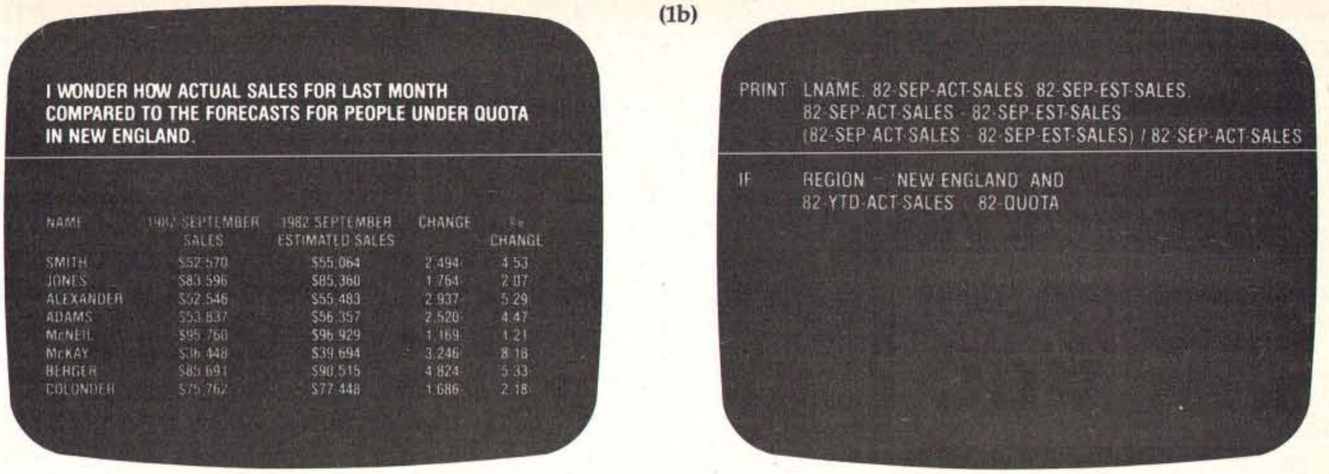
Imagine yourself in the middle of trying to hang a picture. You're standing on a ladder and want your assistant to hand you a hammer. But instead of simply being able to ask for the hammer, you have to stop, get off the ladder, write a small program, debug it, and then run it in order to get the hammer.

Sound ridiculous? Yes, but that's exactly what most people face when they need to get information from computers. To make matters worse, most people don't know the "foreign" language of computers.

In fact, we humans take for granted our unique capability to communicate with each other in a common language. The languages people speak are called *natural languages*. A natural-language (NL) system is one that allows a person to interact with a computer by using the same language he uses to interact with another person. Such a system deals with the richness of English as people use it—along with all its ambiguities—and forgives the typical ungrammatical English that most people use in everyday communication. The NL system must handle commonplace events such as misplaced modifiers, dangling participles, and sentence fragments.

The most obvious advantage of a natural-language system is that people do not have to be trained in a programming language to use a computer. Given the large potential number of users of information and the relatively small number of people who know formal systems, this is of key importance. There is another often overlooked advantage—it can be much easier to express a request in natural language than in a formal language. For example, figure 1 shows the same request phrased in both natural English and in the syntax of an "English-like" program command language. At a glance, it is easy to see how much simpler the English query is to understand, but what surprises many people is the discovery that the English query is shorter than the corresponding formal query.

The underlying reason for this conciseness is that a natural-language system does much more than simply understand the syntax of the language. The system derives much of its usefulness from its understanding of the semantics of natural language. The NL system maps the concepts expressed in words onto underlying concepts that computers can deal



(1a)

```
I WONDER HOW ACTUAL SALES FOR LAST MONTH
COMPARED TO THE FORECASTS FOR PEOPLE UNDER QUOTA
IN NEW ENGLAND.
```

```
NAME        1982 SEPTEMBER    1982 SEPTEMBER    CHANGE      %
                SALES        ESTIMATED SALES             CHANGE
SMITH          $52,570           $55,064        2,494     4.53
JONES          $83,596           $85,360        1,764     2.07
ALEXANDER      $52,546           $55,483        2,937     5.29
ADAMS          $53,837           $56,357        2,520     4.47
McNEIL         $95,760           $96,929        1,169     1.21
McKAY          $36,448           $39,694        3,246     8.18
BERGER         $85,691           $90,515        4,824     5.33
COLONDER       $75,762           $77,448        1,686     2.18
```

(1b)

```
PRINT  LNAME, 82-SEP-ACT-SALES, 82-SEP-EST-SALES,
       82-SEP-ACT-SALES - 82-SEP-EST-SALES,
       (82-SEP-ACT-SALES - 82-SEP-EST-SALES) / 82-SEP-ACT-SALES

IF     REGION = NEW ENGLAND AND
       82-YTD-ACT-SALES < 82-QUOTA
```

Figure 1: *A comparison of English (a) and "English-like" (b) queries.*

with. In later examples, we will see many instances in which the ability of the system to map high-level concepts gives the natural-language system a considerable edge over any formal system.

We'll look briefly at the history of natural-language processing to see how it developed from a research area into a practical, mainframe database query tool. Then we'll examine how natural-language processing fits into the personal computer environment and compare its use with other methods of communicating with computers.

The History of Natural-Language Processing

Natural-language systems evolved from research into Artificial Intelligence, whose goal is to understand human intelligence well enough to produce machines that exhibit intelligent behavior. Understanding natural language was one of the earliest areas of AI research, since it was clearly a unique example of human intelligence.

The first AI work on natural language was in the area of machine translation (MT), using (then) new methods of syntax analysis, developed for understanding computer languages (as in context-free grammars, where language components are defined independent of the context in which they are used. These grammars use recursive definitions, i.e., an <unsigned integer> is defined as a <digit>, or as an <unsigned integer> followed by a <digit>). It was quickly apparent that these "syntactic" based systems were not up to the job. The anecdotal climax of this early machine-translation effort was a system that translated the English sentence "The spirit is willing but the flesh is weak" into a Russian sentence whose literal reading was "The vodka is strong but the meat is rotten."

Since understanding natural languages depends upon better ways of representing semantic information, research switched from the MT effort to "question-answering systems." These systems use a knowledge database to understand and answer questions posed in English. One of the earliest such systems was the Baseball program (reference 4), which contained a database of statistics for one major league season. This research phase culminated in the early 1970s with two prototype systems, both based on the notion of "procedural semantics," in which the meaning of words and concepts is broken down into tasks and subtasks. The Lunar system of Woods (reference 5) could respond to English questions about the data analysis of the Apollo XI moon-rock samples (see figure 2). Winograd's SHRDLU system (reference 3) interpreted English sentences to control the movements of a simulated one-arm robot (see figure 3). Both of these systems contained extremely sophisticated theories of language. Both systems could parse more sentences than they could understand, but in their limited application domains they were quite impressive.

Clearly, more research into semantic representation was required to produce systems capable of understanding the range of English that people routinely use. Most of the research work in AI today is concerned with finding better representation schemes for knowledge. (For a more detailed history of natural-language processing research, see reference 2.) However, a great deal had been learned about the structure of natural languages (particularly English) and about ways for representing and applying the semantics of a limited domain. But was there a practical use for such systems? Woods's work with the Lunar system clearly suggested database query as a promising area. But three problems had to be solved to make this technology commercially viable:

1. *Robustness.* These systems were

How many breccias contain olivine?

What are they?

Do any samples have greater than 13 percent aluminum?

What are those samples?

List K/RB rations for breccias.

Figure 2: *Sample questions interpreted by Woods's Lunar system.*

```
Pick up a big red block.
     OK.

Grasp the pyramid.
     I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.

Find a block which is taller than the one you are holding and put it into the box.
     BY "IT," I ASSUME YOU MEAN THE BLOCK WHICH IS TALLER THAN THE ONE I
     AM HOLDING.

What does the box contain?
     THE BLUE PYRAMID AND THE BLUE BLOCK.

What is the pyramid supported by?
     THE BOX.

How many blocks are not in the box?
     FOUR OF THEM.
```

Figure 3: *A sample dialogue with Winograd's SHRDLU system.*

very sensitive to small errors in typing and grammar. A commercial version needs to forgive minor user mistakes.

2. *Environment.* The natural-language research systems were largely written in LISP, the common language of the AI research community. The "databases" used were home-brew systems developed especially for the natural-language system that used them. To be commercially viable, natural-language database query systems would need to run on standard commercial hardware, in a standard language, and take advantage of the technology developed in commercial database-management systems (DBMSs).
3. *Portability.* The most serious problem of the research systems was the "customization" cost. To adapt one of these systems to a new database typically takes a man-year of effort by an experienced AI researcher.

In 1975, Artificial Intelligence Corporation began work to produce a commercially viable natural-language database query system by concentrating on solving these problems. AIC's product, Intellect, is a robust, portable natural-language system that runs on IBM mainframe computers (see the text box on page 230 for a description of Intellect). It interfaces to most of the popular mainframe DBMSs. Intellect was the first successful commercialization of AI technology.

Use on Mainframes

The most widespread use of natural-language systems today is to provide the ability to query the contents of a database in free-form English. The first generation of commercial natural-language systems required mainframe computers with large amounts of storage and processing power. In addition, the development and refinement of natural-language parsing techniques required a substantial investment in both time and resources, which meant a relatively high price tag ($50,000 to $100,000). However, most major minicomputer vendors are pursuing the addition of a natural-language query facility to their product lines either through internal development efforts or via cooperative marketing agreements with the companies who have already developed this technology.

Database query is a good application for natural-language processing. First, let's define what we mean by the term database query. In order to understand a query, the system must

1) identify specific items of data to retrieve
2) identify criteria for selecting a desired subset of all records in all files
3) determine the analytical and display processes required to manipulate the data
4) invoke the required retrieval, analytic, and display processes in the sequence necessary to answer the question

The technology of natural-language parsing currently works best when the dialogue is limited to a small world view. Database query is unique among natural-language applications in that it quite naturally fits this constraint—the dialogue is limited to the contents of the database.

Knowledge workers need information. A major obstacle to the acceptance of end-user computing has been the unwillingness of the noncomputerist to learn the necessary commands to make effective use of the computer as a resource. Studies of user information needs spurred development of systems whose medium of communication is the highest level end-user language, natural English. Systems offering anything less than comprehension of native English require excessive training of end users, training that is wasted unless the end users work on the system frequently.

Additionally, end users have little or no knowledge about the form in which the information is stored. Even worse, the user's conceptual view of the information has no mapping to the physical or logical format of the data. Users are interested in data access from a high level of abstraction. This means they want the ability to retrieve information in a form immediately useful to them. This often includes

1) *Data summaries:*
   "What were the total commissions paid in the Western sales region last month?"
   "Rank our product lines in terms of profitability."

2) *Implied calculations such as averages and percentages:*
   "What is the average salary in the Accounting Department?"
   "Give me the percentage of total sales in each region."

3) *Aggregation of data over time:*
   "How did our sales in January compare to our sales in March?"

The flexibility of an English query system makes it possible to phrase questions in many different ways.

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Mainframe Versions of Intellect

The current verisons of Intellect run on IBM mainframe computers—the 370, 4300, and 30xx series as well as compatible machines made by Amdahl, National Semiconductor, IPL, and others.

These processors range from the IBM 4321, which is a 0.2 million-instructions-per-second (MIPS) machine to the 3084, which runs at 20 MIPS.

Intellect runs under all three of IBM's mainframe operating systems—VM/CMS, DOS/VSE, and MVS. The Intellect system interfaces to most popular mainframe database management systems, including IDMS, ADABAS, SQL, and VSAM.

Artificial Intelligence Corporation also offers DFAM, its own indexed retrieval system.

The mainframe Intellect system is written primarily in PL/I, with a few routines (less than 10 percent) coded in IBM assembly language.

Depending on the operating system and DBMS interfaces, the Intellect load module is between 600K and 900K bytes. Virtual memory required by each user is approximately 200K bytes.

A license to run Intellect on an IBM mainframe costs $69,500. An optional interface to IBM's PGF graphics package (which allows the user to ask in English for pie charts, bar charts, etc.) costs $15,000.

These fees include one-year maintenance, documentation, training courses at AIC, and applications consulting.

AIC sells Intellect directly, with its own sales force, and through OEM and joint marketing arrangements with other companies (IBM, Cullinet). There are approximately 150 mainframe installations of the system, most of them in Fortune 1000 companies.

Porting Intellect to the personal computer environment has produced no major problems to this stage of the project. There are some differences between Digital Research's PL/I compiler and the IBM mainframe PL/I compiler, but these incompatibilities are overcome by clever coding.

The fact that hardware capability is not an issue in adapting Intellect to personal computers is a testament to the blurring of the lines separating mainframes, minis, and micros.

Some of these may be wordy, while others can be quite concise. In almost all cases, however, it is possible to be more concise in English than with a formal command language. In addition, some English query systems allow references to previous questions using implied pronouns. For example,

> "List the first and last names of the secretaries to our New York City office."
>
> "How many are married?"

Users can vary the selection criteria of a previous question very easily and succinctly:

> "Who are the salespeople over quota in the Eastern region?"
>
> "Western region?"

A simple English dialogue gracefully resolves ambiguities and spelling errors. If an ambiguity is detected, the system requests the user to clarify his intent. The user may be asked to clarify a word that may have multiple meanings in the database (such as New York), to correct a spelling error, or to enter a new definition or conceptual relationship into the system's vocabulary.

These examples show how high-level concepts expressed in natural language can evoke a very complex series of operations in response to a simple question.

A system that can use conversational English to retrieve, analyze, and present information in a useful form will provide knowledge workers and middle- to upper-level managers with tools they desperately need and can use immediately.

Most large companies purchase a number of different application tools from different vendors. Many firms organize these software tools into an internal Information Center. This facility can provide a greater level of analysis, consultation, and support to end users.

A benefit of natural-language query systems is their ability to perform the function of "traffic cop" or integrator. It is highly desirable to have the natural-language interface be the only interface visible to the end user. Users can then issue a single request to have data selected, analyzed, and displayed. They do not have to learn the various command structures and intricacies of separate DBMS, graphics, or display packages. Users request work in ways they are used to.

The natural-language interface overcomes the two traditional problems preventing the information center from being a completely useful facility for the end user. First, each application package or software tool uses its own specific language. Second, these components are usually independent of one another, allowing no communication or control of data transfer among them.

Some NL systems also provide selection, summarization, and analytic capabilities beyond those available in the DBMS. Multiple passes over the data can perform such arithmetic operations as sorting and totaling by category, ranking, obtaining averages, performing comparisons, and formatting the information for output in a report or graph.

In fact, in many companies the natural-language system is becoming the "hub" of the Information Center. In these cases, end users can access many tools, including graphics packages, analysis and modeling systems, application programs, report writers, and DBMSs. The following types of requests are possible:

> "Give me a pie chart of our 1983 sales in New England broken down by state."
>
> "Print a report sorted by department of the average salary, number of employees, and the average departmental salary in-

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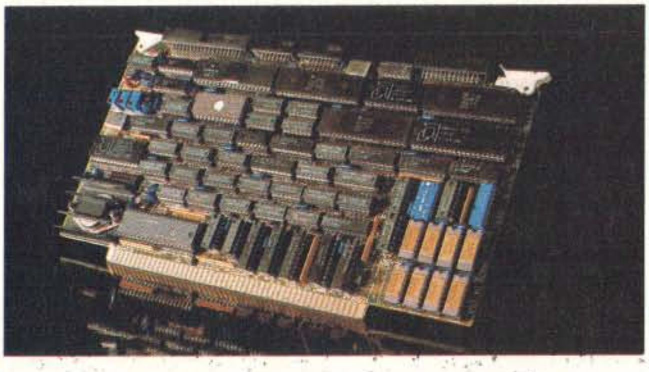

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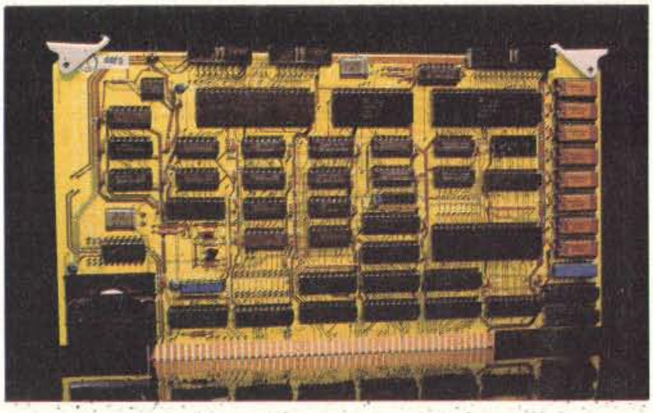

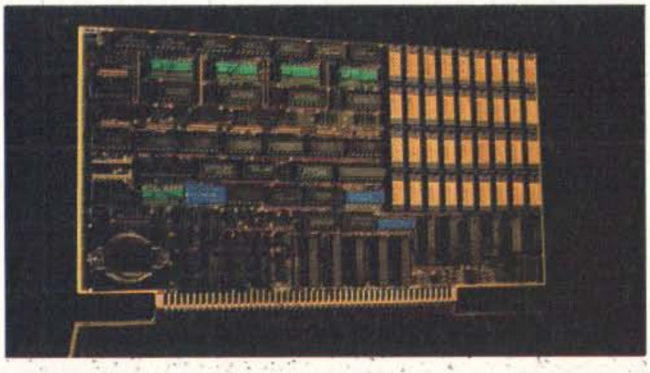

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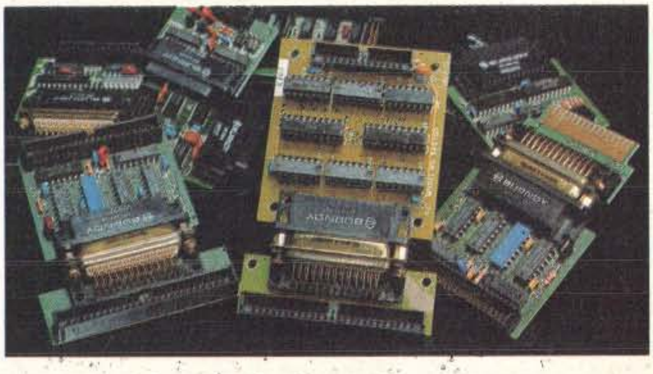

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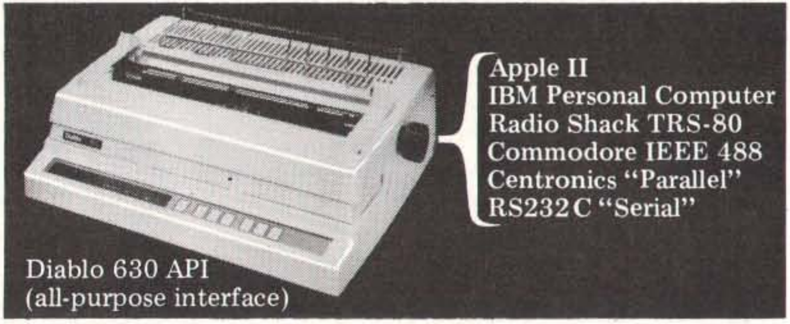

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crease in 1982."

Because the NL query system acts as the supervisor, the underlying work of scheduling and dispatching tasks becomes invisible to the end user. This has both advantages and disadvantages. On the positive side, users can become more productive because they share the ability to issue very powerful commands with far fewer keystrokes. The learning curve is greatly shortened, and users find that the computer is a far more accessible tool.

A drawback may be an overly simplistic view of the amount of work necessary to answer a seemingly simple query. Frequently, questions that appear easy and "cheap" to answer are not, while queries that appear complex are in fact "cheap" in terms of machine resources. This is more likely to be a serious problem in the multiuser mainframe environment, with extremely large databases on line, than with a single-user microcomputer system.

Use on Personal Computers

With the rapidly expanding hardware capabilities of the personal computer, it is now possible to transport natural-language processing technology to the current generation of machines. Increased memory capacity and Winchester-disk technology combined with more sophisticated operating systems such as MS-DOS, Concurrent CP/M, and Unix make the application of this technology commercially viable.

What better fit could there be for the increased accessibility and user friendliness of a natural-language system than in the domain of the personal computer? Some people believe the direct-manipulation metaphor, as exemplified by popular spreadsheet programs such as 1-2-3 and Visicalc, is the best human interface. Others believe that the mouse and window technology of Lisa, Visi On, and Quarterdeck Software's DesQ is the wave of the future. Everyone agrees that integration of applications and tools within a common operating environment (with compatible file structures to facilitate

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data transfer) will become standard. Does natural-language processing technology have a place in relation to these other models?

Natural-language processing will be a complementary, rather than a competitive, component of future personal computer environments. The direct manipulation and mouse/window metaphors are best suited to performing many tasks and will retain a place as the method for performing tasks such as financial planning, data manipulation, and data maintenance. However, it is also true that the power of natural language makes it the method of choice for operations such as database query, analysis, and display.

The trend toward software integration is becoming prevalent in the personal computer industry. Various strategies for achieving integration include

1) the easy transfer of program control and data between applications such as in Lotus's 1-2-3
2) the extension of this concept into a consistent operating environment such as Lisa or Visi On
3) the development of families of generic products from a single manufacturer, such as the Perfect series, the Easy series, etc.—these may have a common command structure across applications
4) the ability to integrate standard, off-the-shelf software products into an operating shell or environment such as Quarterdeck's DesQ

All of these approaches have benefits and drawbacks. Trade-offs must be made in flexibility, functionality, or compatibility. Specific trade-offs include a lack of choice—the application you want may not be available in the environment you've chosen; a higher price—the applications you need may be more expensive because they work in a special environment; and an inability to use software you currently own because it doesn't work in a particular environment.

A natural-language interface can enhance any of these models. English can exist as a layer under an operating shell to perform supervisory tasks. It can act as an integrator as well as a supervisor to facilitate communication and data transfer among different software products. It can act as the simple, easy-to-use human interface for people who want access to information without needing or wanting to become familiar with the underlying components.

As a result of the power of the English language to concisely express complex commands, a natural-language front-end can greatly simplify the amount and complexity of keystrokes or "mouse picks" necessary to perform an identical operation with non-English commands.

For example, consider a database consisting of a file with information on the Fortune 500 companies for 1981. Each record consists of the following fields:

Company Name
City
State
Industry

1981 Assets
1981 Income
1981 Equity
Number of Employees

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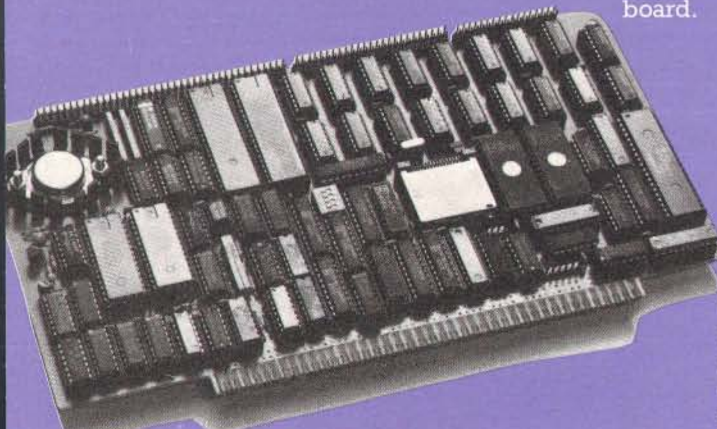

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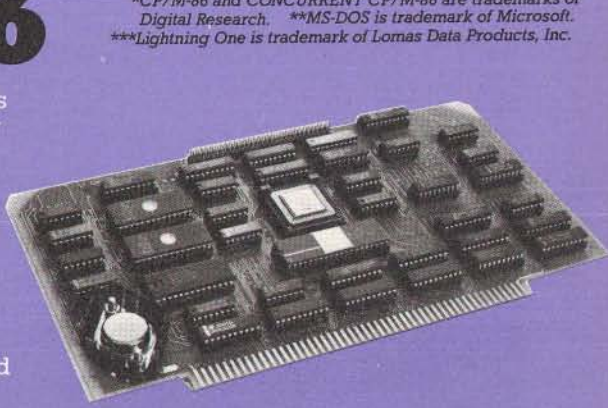

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Of these fields, the state, industry, and 1981 income are indexed.

Let's compare the command sequences necessary to perform database retrieval and analysis with dBase II vs. the natural-language query system, Intellect.

In order to find the companies located in California with sales over $10 million, dBase II requires that we type

```
LIST ALL COMPANY, STATE,
SALES81, FOR STATE='CA'
.AND. SALES81> 10000000
```

With English query, it is possible to type

> "List the companies in California with sales over 10,000,000."

or

> "CA with sales over 10,000,000."

(This question can be phrased several ways to obtain the correct answer. Note, too, that the inflection of the word "companies" to "company" is implicit in English but must be the exact field name in dBase II.)

The advantage of natural language is most apparent when further selection criteria or substitutions are desired. For example, if you want to add the selection criterion of companies employing over 10,000 people to the previous question, with dBase II you must reenter the complete query with the new selection criterion:

```
LIST ALL COMPANY, STATE,
SALES81, FOR STATE='CA'
.AND. SALES81> 10000000
.AND. EMPLOY81>10000
```

With English, we can type

> "Also over 10,000 employees."

To substitute Illinois for California, the entire query would need to be retyped with "STATE='IL' in dBase II. With English, we can type "in Illinois" or "in IL."

The natural-language system can

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further summarize the data—ranking, averaging, and doing comparisons as well as producing pie charts, bar graphs, and histograms. It can also format the data for output to a report or graphics package. These examples demonstrate that natural-language technology has a place in the personal computer market.

What is required to make this current level of mainframe performance available to today's microcomputers? Before the advent of 16-bit systems with increased memory, hard disks, and faster microprocessors, the most serious problem was simply one of size. However, computers such as IBM's PC XT and Apple's Lisa clearly have the horsepower to run large, complex programs. In fact, the amount of computation available to a personal computer user may exceed the share of resources available to a timesharing user on a large mainframe.

The advantage of natural language is most apparent when further selection criteria or substitutions are designed.

The most serious issue with making natural-language query systems available to personal computer users is the same issue that concerns any effort to make mainframe technology available—the necessity to make the entire system usable by a person who is not a data-processing professional. In the mainframe arena, there is often a clear distinction between the people who have a need to query the information base and those responsible for creating and maintaining it. While there will certainly be cases in which personal computer users want to query data prepared by some other person or group, a common case will be the one in which a single individual is the user of the information and the database designer, data-entry clerk, and system programmer. In order to allow this "jack of all trades" to easily define, create, maintain, and query databases in natural languages, one approach is being taken by Symantec, a company founded by Gary Hendrix from the Stanford Research Institute. In this system, all the functions a user desires are part of the natural-language system itself. This approach is somewhat analogous to the 1-2-3 system, in which all functions are provided under a single umbrella.

Another approach is being taken by AIC in its development of a personal computer version of Intellect. This approach involves interfacing on the input side with popular personal computer database systems such as dBase II. On the output side, Intellect will allow data to be displayed by already existing personal computer graphics packages and even by a spreadsheet package such as Visicalc, Multiplan, or 1-2-3. This approach enables users to preserve their existing investment (of both dollars and time) and permits use of the "best" technique for getting the job done. Data may be retrieved and summarized by Intellect and then presented to a spreadsheet for further manipulation.

A problem with this approach is integrating the database system's definition of a concept (such as a field or a value) with that of the natural-language system. On the mainframe side, this job has traditionally been done by support personnel in the DP group. On the personal computer side, the user will have to perform this integration.

Let's say, for example, that we have a database of all the personnel in a small company. The data includes name, job, age, salary, address, department, date hired, and so on. We assume that the system has access to all the information in the database (such as the name of each field and its contents). When the user first sits down with the system, he might type

> "List the earnings of everyone in the shipping department."

Since the system knows only the names of the fields in the database system, it would not know the word

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"earnings."

The system must give the user a choice as to what the unknown word "earnings" means. It could simply be a misspelling of some word the system knows. Or, as in this case, the user intends the word as a synonym for the already known word "salary." If the user were to type "List all the executives," the correct definition of "executive" might be anyone who has the title of president, vice-president, or director.

The system "learns" the vocabulary of the user over time. This is, of course, the most basic form of learning ("learning by being told") and is, in fact, how people acquire much of their knowledge.

The personal computer version of Intellect—which will be written in PL/I, as is the mainframe version—is currently under development. The product will be ready for shipment in 1984. An IBM PC with 512K bytes of memory and a hard disk will be the minimum initial target machine.

Business people are the target users of a PC version of Intellect. They require access to information stored in both mainframe and microcomputer databases. They also need timely and flexible analysis and display capabilities. A concurrent or multitasking operating-system environment will best provide this flexibility. The use of windows and pointing devices (mice) may also contribute to this environment. Users need the ability to search a database while concurrently examining a spreadsheet or printing a report.

It is planned that the initial version of Intellect will integrate English query with several popular commercial microcomputer and mainframe DBMS packages and provide output to popular graphics and spreadsheet programs for further data analysis and manipulation. In most cases, AIC intends to integrate its natural-language technology with existing applications software rather than develop a proprietary line of applications. In some cases, AIC may choose to enhance a capability of an existing product rather than, or in addition to, interfacing with a third-party package.

Intellect allows the end user to dynamically and interactively enhance the vocabulary and concepts available to Intellect. It will permit users to create and populate a new database or use data definitions previously defined in a DBMS or file manager. A future goal of the product is to allow all user customization and fluency enhancements to be performed interactively. Another planned enhancement is to allow users to dynamically modify as well as query data.

Summary

We have seen examples of the current level of natural-language technology in the mainframe world and examined its place in the personal computer environment. This technology will not replace the "direct manipulation" paradigm but rather complement it, giving the user a choice of the best tool to accomplish a particular task. Given the power of today's personal computers, it is only a matter of time before several natural-language systems will be available. ■

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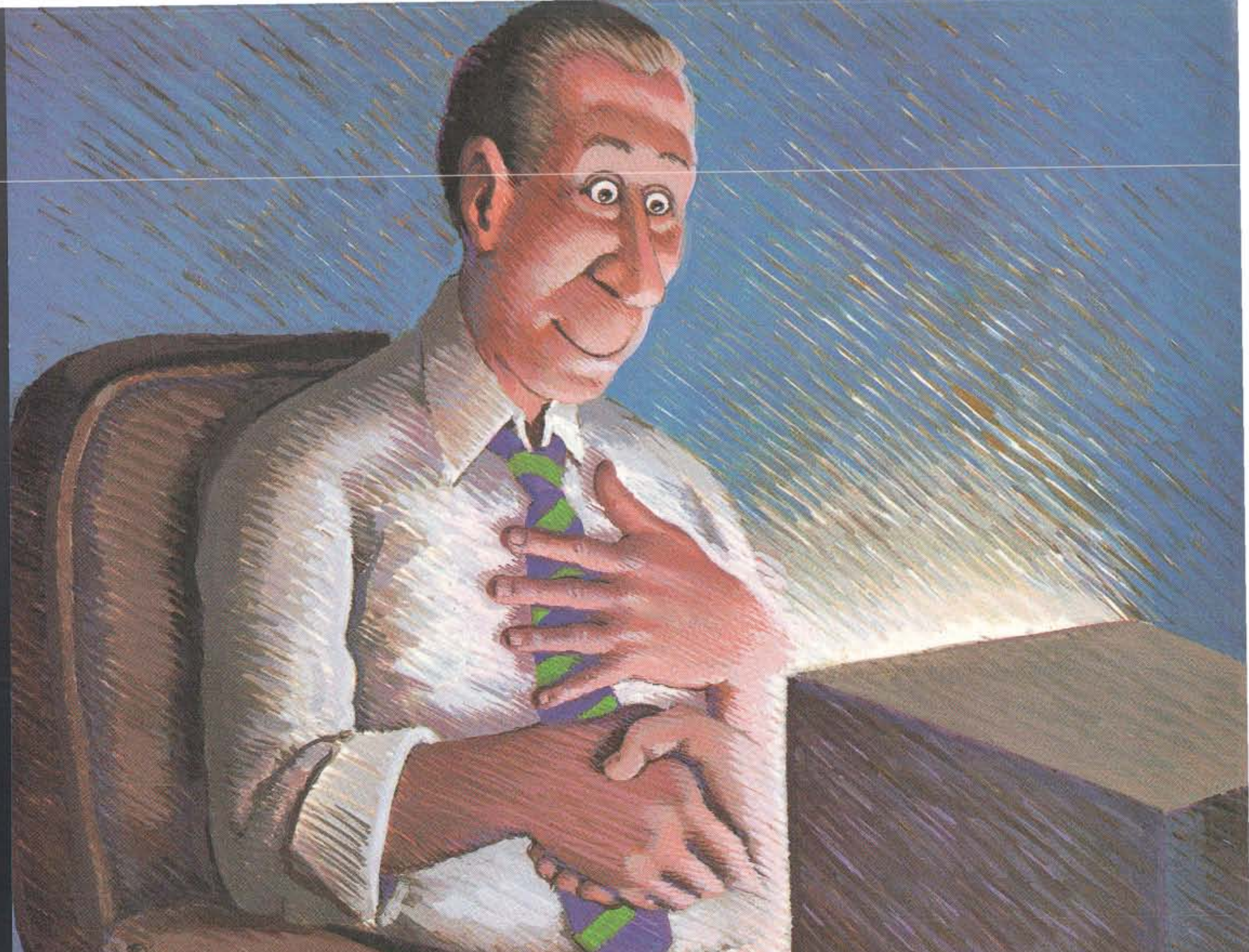

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Portables—1984 and Beyond

Idea-Processing Software and Portable Computers

The new wave of computers demands new software

by David Winer and Peter Winer

Imagine you've arrived at a business appointment 10 minutes early. Instead of killing time flipping through a magazine, you reach into your briefcase and pull out a portable computer. You turn the power on and move the cursor through an outline of the points you want to cover in the meeting.

After a small reorganization (you wanted to discuss the project schedule after discussing personnel requirements), you move the cursor down to the financial-projections section and press the key marked Spreadsheet. Instantly, a small window opens up on the screen, and you try a few calculations and decide that your assumptions make sense. Turning the power off, you spend the next five minutes browsing through a magazine.

In 1977, Alan Kay (then at Xerox's Palo Alto Research Center and now chief scientist at Atari) speculated about the design and use of portable computers. It was just speculation then, but now, in 1984, it's real—people are buying and using portable computers that are very much like the "Dynabook" that Kay described.

1984 is the year that the personal computer leaps off your desktop and into your briefcase, your knapsack, or your shopping bag. Before facing the wide-open future of software for portable computers, let's look at the history of portable computing.

A Short History

The first portable computers existed before personal desktop computers, before Wordstar and Visicalc and even CP/M. Texas Instruments' Silent 700 terminal, with a built-in modem, a full keyboard, and a thermal printer, was portable, even though it weighed almost 50 pounds. It had a handle on it; you were *supposed* to carry it around with you. In 1973, some people actually did, risking sore arms and back. The convenience of carrying around computer power was worth some discomfort.

Then came the personal computers, desktop machines made by Apple, Commodore, Radio Shack, then IBM, and so on. By 1981, some even had handles (e.g., Osborne and Kaypro). This meant you could carry "transportable" desktop-computer power somewhat less painfully (the Compaq Portable Computer, introduced in 1982, weighs only 28 pounds).

Transportables aren't fully portable. Like old tabletop radios, they're too heavy to be carried conveniently, and they must be plugged into a wall socket. Transportables haven't begotten new types of software; they come bundled with the usual desktop software (word processors, spreadsheets, database packages) and the usual software support structures (CP/M on the low end, spelling checkers and program generators on the high end). So much software comes bundled with the transportables that the market for software specific to them has never developed substantially. Even Compaq, which bundles only the operating-system software and a disk-based version of BASIC, has little software built specifically to exploit its transportability.

This trend is not surprising. The manufacturers of transportables spend a lot of advertising dollars to portray their machines as nothing more, nothing less, than transportable clones of the desktop machines they are emulating. This is an effective short-term strategy, but in the long term it has caused software manufacturers to ignore the special communications capabilities that many transportable units have.

In 1983, the first useful portable computer, the Radio Shack Model 100, was introduced. Manufactured in Japan by Kyocera and marketed in the U.S. by Tandy, the Model 100 has caught on in a spectacular manner and points the way toward truly convenient portable computing.

A Successful Design

Why was the Model 100 such a breakthrough? Basically, there are three reasons: its screen, its keyboard, and its software. Before the Model 100, portables typically had much smaller liquid-crystal display (LCD) screens. The Epson HX-20 with its 4-line by 20-column display can't compare with the 8-line by 40-column display of the Model 100. For most people a 4 by 20 display isn't big enough. An 8 by 40 screen is barely adequate, but on the Model 100 it is workable. The smaller screens on other computers fail to meet the requirements of effective personal computing.

The keyboard on the Model 100 uses the standard QWERTY layout and has eight function keys, four arrow keys, and several dedicated function keys. You can touch-type on this keyboard; the full-size keys have a solid feel.

The system software of the Model 100 is stored in ROM (read-only memory). Turning on the machine automatically takes you into the top level of this software. From there, you can move a cursor over a menu of files, which can be BASIC programs or text files. You can edit a text file, run a BASIC program, or search a text file in several ways. Terminal software is included, enabling file transfers over the built-in modem, serial port or parallel port, and remote access to computer networks and bulletin boards.

Although significant, the Model 100 is just a transition product. An effective portable of the future will have a full 25 by 80 screen, more memory, a 16-bit processor, and software that is better adapted for portability. The year 1984 is when such a portable, weighing less than 10 pounds, will appear on the market. How will such a computer fit into our lives?

Applications

Clearly, as the Model 100 illustrates, software for portable computers is different from software for desktop computers. The companies behind the machine invented a new style of portable computer—one intended to assist in a broad range of applications including BASIC programming, text editing, appointment scheduling, name and address lookup, and communications.

Let's consider the problem of designing software for the ideal portable, one with sufficient memory (say 256K bytes) a faster processor (8086 or 68000), a larger screen (25 by 80), and maybe even a disk drive. How would software for this portable be designed?

Although significant, the Model 100 is just a transition product.

Before implementing the first prototype, any good software designer will sit down and pose a few crucial questions dealing with the "who, what, why, and where" of the software product.

Who will be using the software? How much experience do they have with personal computers? How old are they? Are they male or female? How much education do they have? How much money do they make?

What will they do with the software? Should the software be targeted at a particular task?

Why are they using the computer instead of paper and pencil?

Where will the computer be used? Now that we're designing software for portable computers, we have to consider "laptop," "bedtop," "beachtop," "coffee-tabletop," and "floortop" use.

To be effective, the software for a portable computer has to be adaptable to a variety of situations, therefore it has to accommodate a variety of information structures. Standalone software that's simple enough to be used on the run must also be capable of producing sophisticated results. It must be simple, with small reference cards instead of extensive users manuals. The best portable software will appeal to the same broad market in which Atari and Coleco video-game machines sold in 1981. Simplicity will be one of the most significant factors in the success of portable software.

Our informal interviews with users of the Model 100 have yielded some clues to the who, what, why, and where of portable software.

Today, the primary users of portable computers are people who also use desktop computers. Therefore, a highly valued feature is the ability to upload and download information between the portable unit and the desktop unit. But eventually, just as portable radios and portable cassette players created their own markets, portable computers will appeal to people who aren't currently using desktop computers.

Most Model 100 owners use the machine for fact gathering, notetaking, simple calculating, organizing, and thinking, with little or no BASIC programming. (Many said they use the BASIC interpreter as a calculator, for computing ratios or summing numbers.) Our interviews indicated that the text editor is the program used most often; name/address lookup and scheduling are the programs used least often. There was not much demand expressed for full-blown word-processing, and spreadsheet capability was considered important only by "spreadsheet people." The need for a relational database package (such as dBASE II and PFS) was expressed by consultants with extensive bases of information to draw from.

Most users said they enjoy the convenience of a portable computer. Portables are also used to fill small gaps of time, time that would otherwise be wasted. There seems to be no limit on where a Model 100 is used: airplanes, podiums, parties, waiting rooms, restaurants, and hotel rooms.

A Design for Portable Software

Now we have a feel for the who, what, why, and where of portable computing. After talking with users of the current technology, we're ready to embark on some speculation about the future of portable software.

Will conventional database managers be the best operating software on portables? Probably not. Database-managing packages require that organization be preplanned, that all manipulation of structure take place *before* any information is entered. Database products such as dBASE II and PFS require that each fact or idea fit into a given layout or "template." The implementation of this type of database, no matter how user-friendly, can serve effectively only for applications such as accounting, mass scheduling, and mailing lists, in which the format of all information can be determined in advance.

More appropriate for the user of a portable computer is a database system that accommodates flexible organization and reorganization of concepts, ideas, or outlines and is not limited to records, fields, and files. A system should let a small section be reorganized without affecting material in other sections of the database.

Using such an "idea-processing" software package is the opposite of production-oriented software or "productivity software." Word processors, a prime example of production-oriented software, take finished presentations and turn them into attractive printed documents. Taken to the limit in a desktop environment, word processing incorporates graphics and typesetting capabilities—advanced features, yes, but the wrong set of features for idea processing. The right features for idea processing are "soft" concepts such as outlining, structural editing, and easy manipulation of displayed information.

Idea-processing software supports brainstorming, fact compilation, organizing, and reorganizing. Idea processors exist in the noncomputer world; for example, notebooks, index cards, blackboards, and appointment books are all idea-processing tools, much as a typewriter is a noncomputer word processor.

Good idea-processing software supports the belief that the world is a chaotic, disorderly, rapidly changing information structure, not a predictable table of rows and columns. With an idea processor you can easily add new facts and ideas and then painlessly reorganize the rest of your model to reflect the change. Idea processing does not exclude the need for word processing; it's useful to have a link between a portable idea processor and a desktop word processor.

Dimensions of the Portable Industry

We've mentioned two portable machines, the Radio Shack Model 100 and our hypothetical 16-bit, 256K-byte, 10-pound "ideal machine." But there are many other machines that qualify as truly portable: the Gavilan, Convergent Technologies' Workslate, GRID Systems' Compass, Sharp's PC-5000, as well as others that are just being introduced. (See Septem-

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ber 1983 BYTE, pages 36-44, for a comparative list of portables.)

The trend is upward. The newer machines have lower prices and higher performance, screens and memories are larger, and 16-bit processors are more common. When the market for portables matures two or three years from now, what will a portable computer look like? We guess that there will be three "levels" of portability, each defined in terms of price, capability, and bulk.

Machines at the lowest level will cost about $250 and will use technology similar to that of the Model 100 with a minimum-sized screen, a full keyboard, and no disk drive. It will run a refined version of the Model 100 software (no BASIC, better idea-processing software, less emphasis on specific applications such as an address book and scheduler).

The middle-level machine will cost about $1500 and will provide the functionality of our mythical 256K-byte portable, but it will not have a disk drive. The unit will run ROM-based software, will be compatible with the standard desktop operating systems, and will interface to standard desktop computers as a keyboard. The operating software on this portable will offer sophisticated and easy access to the desktop's printer, typesetter, hard disk, and networking capabilities. Applications software will be up- and downloaded with a single keystroke. A large number of portable-specific applications will be available, including more powerful idea-processing software. It will connect to RS-232C devices and phone lines. Watch for radio communications, an interface to the developing cellular radio network. Because the middle-level portable will not have a disk drive, the bulk of the unit will be only slightly larger than the $250 machine.

The high-level machine will have more memory, a disk drive, perhaps a small printer, and will sell for $2500 to $5000. It will have all the capabilities of the middle-level machine, but it will also weigh more (as much as 25 pounds) and thus be less portable. There will be a smaller market for this machine; it will be aimed at those people who need to carry an entire computer system with them (e.g., consultants with large databases).

Future Developments

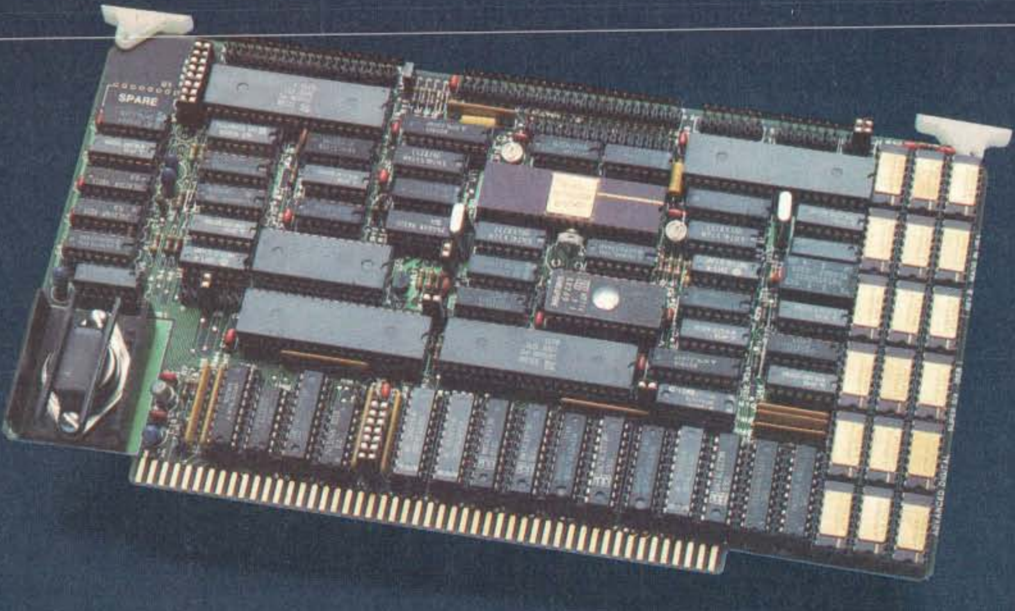
How big will the portable-computer industry be, and what impact will it have on society? We believe that the machines at the lowest level will sell in the same mass-market numbers as Atari and Coleco game machines did in 1982. The industry that will serve this huge base of people using portables will be very broad. Users will need software, hardware, and means of hooking into phone and cable networks. They'll need services such as electronic mail and bulletin boards, training, and maintenance—many of the same services that current users of desktop computers need but in larger numbers and with more emphasis on communications and convenience. Certainly, having computers that travel increases the number of places that can be tied into a computer network.

Will portables finally force the development of a national computer resource for mail and messages or a standard for high-level communications? We think so, but it may take as long as five years for such sophistication to develop in the market. Currently, users of the Model 100 and other portables are communicating through networks such as The Source and Compuserve. Yet, because of the current price and performance of these services, we don't expect portable-computer users to turn these networks into mass-market consumables.

A new breed of software will be needed for desktops and mainframes. The bigger machines will have to monitor telephones and respond to commands when you dial in using a portable computer. Bulletin-board software will evolve into an efficient way to access desktop and mainframe resources from remote locations.■

David Winer is president of Living Videotext Inc. (Suite 232, 1000 Elwell Court, Palo Alto, CA 94303). Peter Winer is a software consultant based in Brighton, MA.

SUPER SIX™



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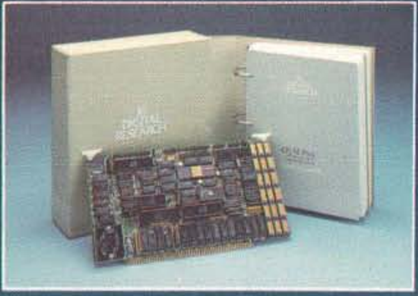

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Beyond the Application Program

A Different Approach to Integrated Software

Element managers that implement objects such as spreadsheet tables and text paragraphs may supplant the traditional concept of the application program

by John Banning

To bring the benefits of personal computers to professionals who travel widely, portable computers must have a basic set of facilities for data storage, data manipulation, and data transmission. These facilities include a word processor, a spreadsheet, a personal database, and a combination terminal-emulator and file-transfer system.

Since travelers lack luggage space for reference manuals, software in portable computers must be easy to learn how to use and, perhaps more important, easy to remember how to use. This requires a user interface that is visual—one that lets the user see what is going on—and one that is consistent across all applications. Moreover, the consistent user interface must let the user create documents that include data from two or more different applications.

This article describes what we at Gavilan Computer Corporation believe is an innovative approach to integrating software for portable computers in order to achieve high functionality and ease of use. Our software has antecedents in the object-oriented software developed at the Xerox Palo Alto Research Center and described in the August 1981 issue of BYTE. After orienting you in the outward appearance and fundamental terms of our software and discussing our development tools, I will discuss the structure of our software, which actually puts the user interface in charge of the computer, and the integrated application facilities, which are provided through "elements" and "element managers" rather than different application programs, each with its own unique kind of document with its own unique structure.

Software in portable computers must be easy to learn how to use and easy to remember how to use.

The element-manager approach lets users have different kinds of objects, such as paragraphs and spreadsheet tables, in the same document, and lets the objects retain their normal behavior and functionality. For example, a spreadsheet table appearing in a letter can still recalculate if a value used in one of its formulas is changed.

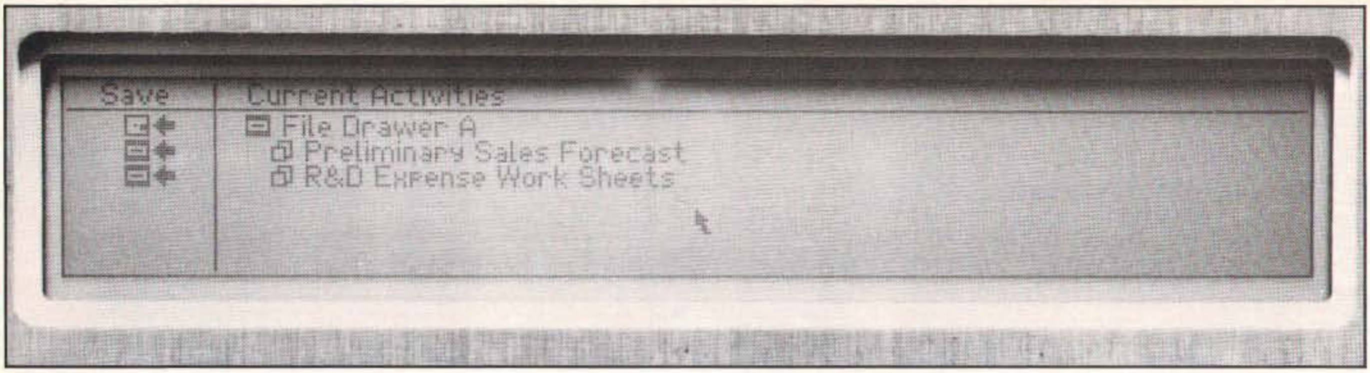
Orientation

Gavilan's approach to building easy-to-understand software is based on objects whose state the user can observe directly (because that state is displayed on the screen). The user manipulates these objects with a small, uniform set of operations. In addition, these objects are based on things that are familiar to most users: file drawers, file folders, documents, paragraphs, and so forth.

Photo 1 shows an image of what is called the desktop as displayed on the portable computer's screen. On it are a file drawer and a number of documents, each tagged with an image (called an icon) that suggests a kind of object (the front of a file drawer or two overlapped pages of a document). These images on the desktop represent objects that are open and thus accessible to a user. This view can always be brought up by pressing the Desk Top button on the control area on the front of the computer (figure 1).

Also visible (near the center of the photo 1 screen) is a small arrow. By moving your finger over the touch pad on the front of the unit (the blank area in the middle of the control area shown in figure 1), you can move this arrow around, pointing it at things on the screen. This is the key that ties together the visual nature of the interface (the ability to

← Circle 103 on inquiry card.



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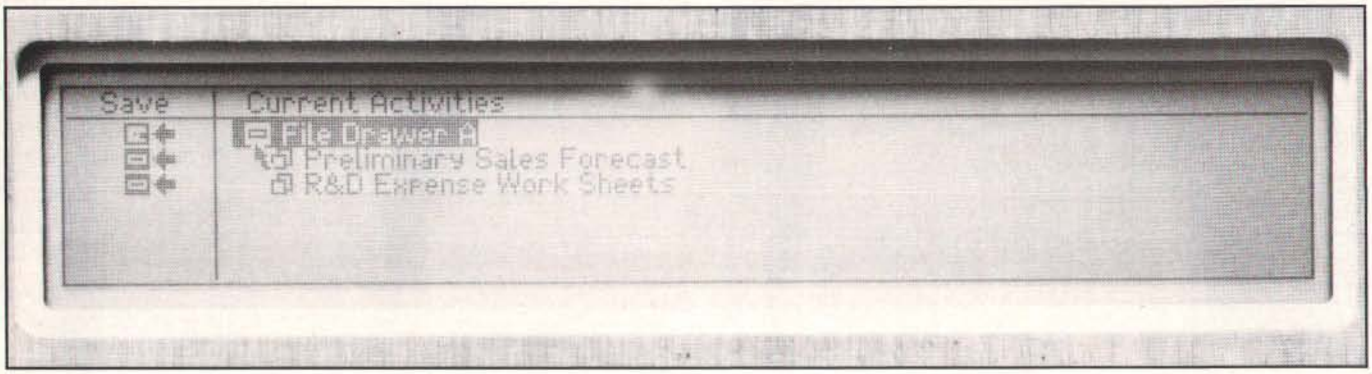
Current Activities

File Drawer A

Preliminary Sales Forecast

R&D Expense Work Sheets

Photo 1: *The Gavilan computer's desktop image.*



Save

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Photo 2: *A display illustrating the selection of file drawer A.*

view documents directly) with the manipulation of objects. Instead of remembering object and command names and typing them into the computer, you point to an object and an operation.

You can point to the desktop icon of one of the open objects (photo 2), and then, by pressing the Select button (see figure 1), indicate that you would like to examine the contents of that object.

If this "on-screen button" operation is performed to select the photo 2 file drawer, what you might see is shown in photo 3: the file-drawer contents, which consist of file folders and documents arranged in outline form. Again the pictorial icons suggest the kind of object you are looking at. As with the desktop, the contents of a document can be viewed by pointing to the document icon and pressing the Select button.

But you can also select data that is displayed in the file drawer (the names of the documents and file folders) by pointing at a document name and pressing the Select button. Having selected part of an object, you can perform any number of editing operations on it such as typing into it or (by pressing the appropriate button) deleting, moving, or copying it. By pressing the figure 1 Menu button, a whole list of on-screen buttons for various standard operations can be called up (photo 4) and then selected. The operations available here are exactly the same ones that would be used to edit or otherwise manipulate a paragraph or a spreadsheet.

As with the desktop, by pointing to a document's viewing icon and pressing the Select button, you can look at the contents of a document. Photo 5, for example, shows text arranged in a paragraph, followed by the cells of a spreadsheet table. Again, by pointing to a particular object, you can select data in that object and do an operation on it.

Note that by selecting data in the paragraph, you begin interacting (through the human-interface software) with the word-processing ap-

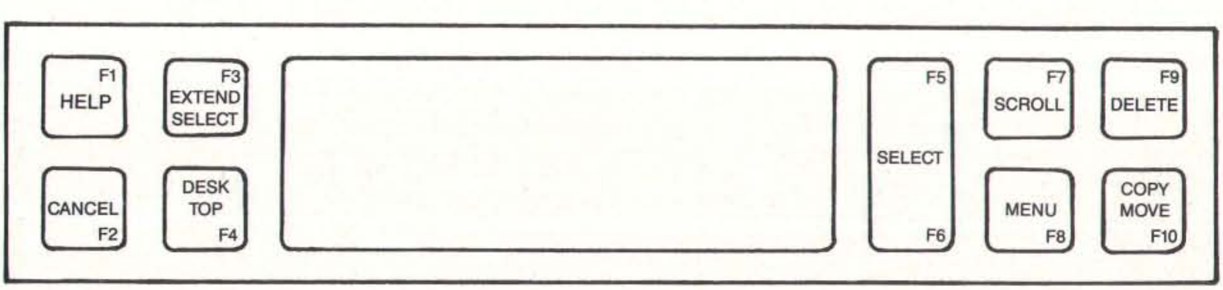

Figure 1: *The Gavilan computer's control area.*

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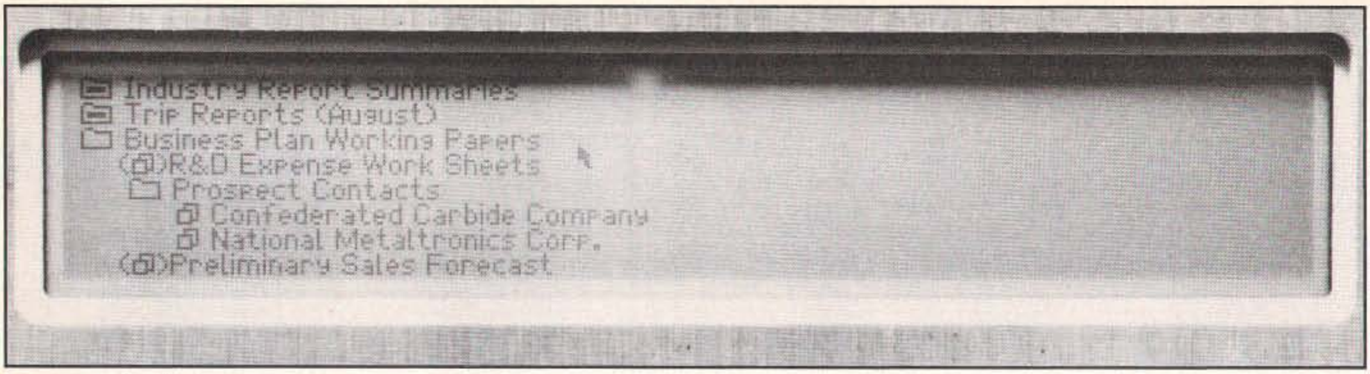

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Photo 3: *The file-drawer contents.*

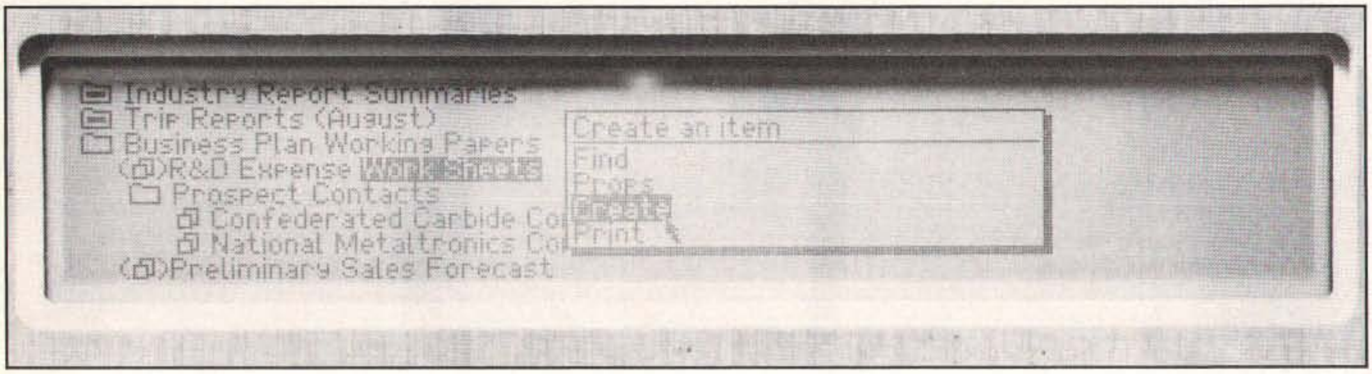

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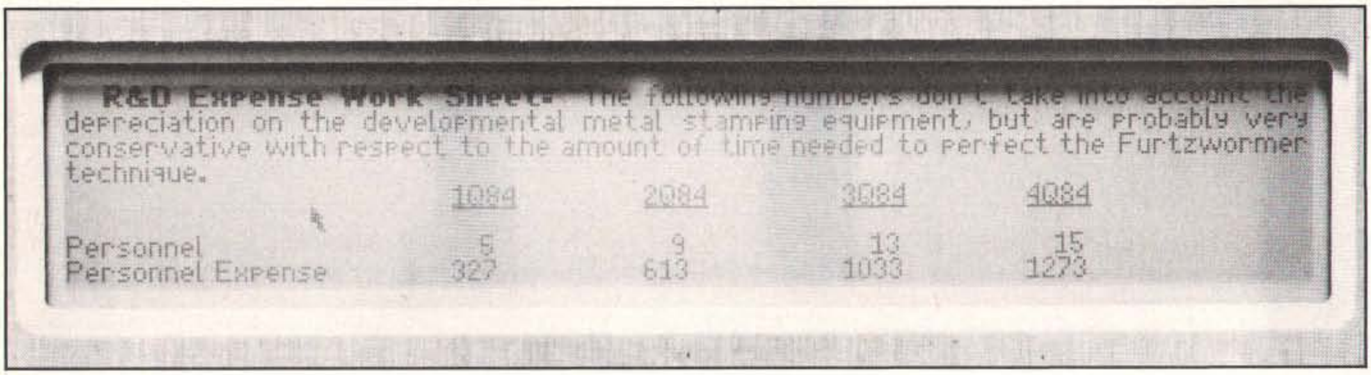
Photo 4: *Pressing the menu button brings a list of on-screen buttons onto the photo 3 screen.*



R&D Expense Work Sheet• The following numbers don't take into account the depreciation on the developmental metal stamping equipment, but are probably very conservative with respect to the amount of time needed to perfect the Furtzwormer technique.

	1Q84	2Q84	3Q84	4Q84
Personnel	5	9	13	15
Personnel Expense	327	613	1033	1273

Photo 5: *Document contents.*

plication. If you were to move the arrow down to the spreadsheet and select data there, you would be interacting with the spreadsheet application. Thus, the idea of a program as something the user has to understand and deal with has been replaced with objects that users view and directly manipulate by following a few simple rules.

One of the standard operations that can be performed on an object is the Properties command (photo 6), which lets you view or set some property of an object. Selecting this command for a paragraph (photo 7) shows that you can set character properties, general paragraph properties, or properties controlling the printing of paragraphs. By selecting character properties (photo 8), you get a form that can be filled in to set such features as boldface or italics. Thus, the property mechanism offers a uniform way of handling various properties of different kinds of objects, helping to keep the number of operations in the system small.

Structure

Figure 2 shows the overall structure of the software that Gavilan has built to implement this visual, object-oriented approach.

This software is written in Interpac, a proprietary language. Thus, the bottom level of the software, which provides the environment for the rest of the software, is the interpreter for the Interpac language.

The operating system is designed not only to handle specialized aspects of portable computing (e.g., power and battery control), but also to provide the fundamental services necessary to build an object-oriented software system. These include a multitasking monitor (to support multiple

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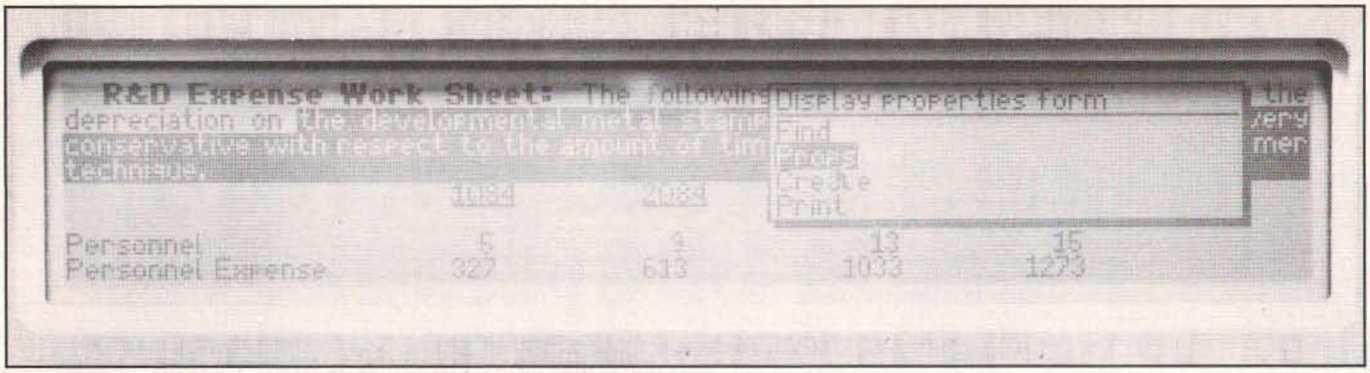

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depreciation on the developmental metal stam very
conservative with respect to the amount of tim mer
technique.

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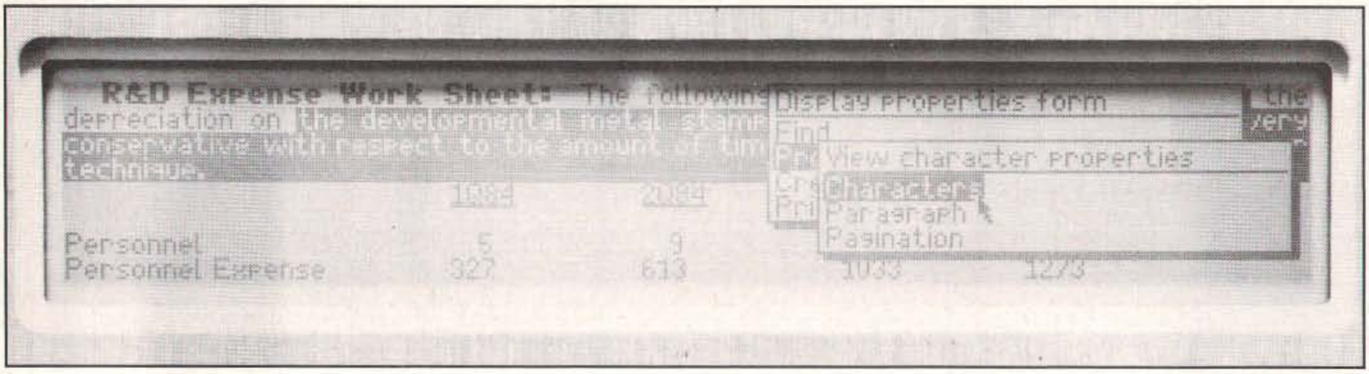
Personnel Expense	327	613	1033	1273

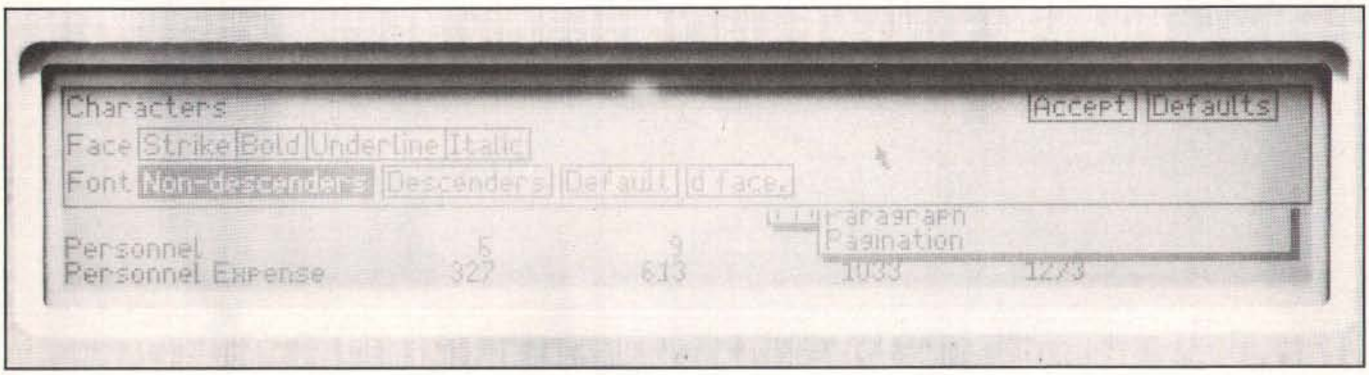
Photo 6: *Selection of the Properties command.*



R&D Expense Work Sheet: The followin the
depreciation on the developmental metal stam very
conservative with respect to the amount of tim
technique.

	1984	2084		
Personnel	5	9		
Personnel Expense	327	613	1033	1273

Photo 7: *On-screen buttons allowing selection of character, paragraph, or pagination properties.*



Characters

Face: Strike, Bold, Underline, Italic

Font: Non-descenders, Descenders, Default, d face.

Personnel	5	9		
Personnel Expense	327	613	1033	1273

Photo 8: *Selectable character properties.*

documents to be open on the desktop at one time) and block-structured access to the disk and main memory.

Holding the objects that a user views and manipulates is the job of the data-structuring software. It provides object-oriented data structures that are built on the blocks of the operating system's disk and memory services.

The human-interface software handles all interaction with the end user and thus has primary responsibility for creating the visual access to the objects held by the data-structuring software and the commands that work on them. The element managers shown next to the data-structuring software in figure 2 are the main kind of application facility in this object-oriented system.

The development of this software has all been done on Bell Laboratories' Unix operating system using a number of compiling and debugging tools.

Tools

Interpac, the language Gavilan's software is written in, is based on the FORTH language. The choice of FORTH was dictated by a number of considerations. First, it was important to have compact code, as the task before us was to generate a very sophisticated piece of software that must run in a limited amount of memory. At the same time, it was important to sustain a high level of execution performance so that adequate response to the end user could be provided.

FORTH is ideally suited to these conflicting goals, as its interpreted form can be made compact, and the

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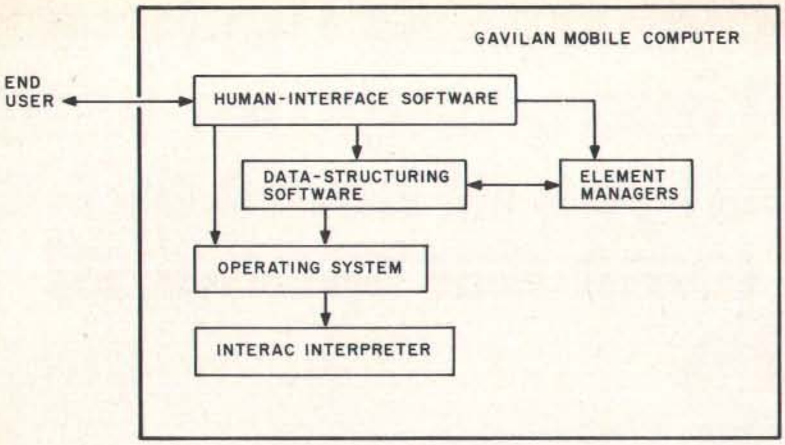

Figure 2: *The structure of the Gavilan computer's software, showing the main software components and their relation to one another.*

structure of the language gives the programmer sufficient control to generate efficient code. FORTH also accommodates the insertion of assembly-language routines in those cases where performance analysis indicates that assembly language will provide substantial improvements.

Another important quality that Interpac has inherited from FORTH is the way it encourages the structuring of software in layers of abstraction. Each layer of FORTH "words" ("procedures" in conventional terms) is built on the lower layer and provides a more sophisticated level of abstraction to the next layer. This structure is particularly natural in that all operations in FORTH access their arguments in the same way regardless of whether they are part of or built on top of the base language.

FORTH in its pure form has some drawbacks that needed to be corrected. The combined interactive interpreter and compiler of classic FORTH has been replaced by an Interpac compiler that runs under Unix. This Interpac compiler generates much tighter code than that of standard FORTH, using techniques such as single-byte encoding of Interpac words and constant values.

In addition, a number of changes to the language were made to promote good software-engineering practice. Declaration of Pascal-like data structures was introduced to allow intelligible data-structure descriptions. Declaration of parameters on FORTH words was added to provide better documentation and allow for automatic type checking. Stack marking and local variables were added to allow more complex words to be created in a straightforward manner. A module structure was introduced to express modular decomposition and the attendant hiding of data structures and implementation details.

Along with the Interpac language and its compiler, a number of other tools were created. A remote debugger allows us to download programs from the Unix system to a target Gavilan unit and do symbolic debugging from the Unix system with a minimal impact on the target environment. This debugger also forms the basis for a performance monitor that tells us how much time is spent in each Interpac word and a test-coverage monitor that tells us what code has not been exercised by a particular test.

A message-compression utility allows us to compress by a factor of four the English (or French or German, etc.) text files used in error messages, menus, and the help facility.

Third-party software developers have a similar set of tools available to them. The difference is that they run under MS/DOS on the Gavilan unit or the IBM PC or XT and use the C programming language rather than Interpac.

System Software

The operating system manages and controls the basic resources of the system, including not only device drivers for the computer's I/O devices, but also control of power to the peripherals and processor.

Because peripherals can be added on to the unit and applications capsules plugged into the unit, the operating system provides services for locating a particular device or application. These services include a logical I/O system that routes commands from the rest of the software and interrupts from the hardware to the appropriate device driver. (Device drivers are typically contained in the peripheral that they control, and the operating system provides a general way of accessing them.)

Two functions of the operating system contribute significantly to the particular goals of the rest of the portable computer's software. The first of these is the management of the microprocessor tasks by way of multiple tasks synchronized through semaphores. This approach allows multiple activities to proceed simultaneously in the system and provides the basis for having multiple documents open on the on-screen desktop—just as you might have on a real desk. It also provides an elegant mechanism for power control: whenever the process dispatcher cannot find any tasks that are ready to run, it saves the processor's state and turns the power off (power is automatically restored by the next interrupt).

The second way in which the operating system supports the user's view of the portable computer is through the block manager, which manages secondary storage to devices such as floppy disks. The block manager provides a uniform view of blocks, whether they are on the floppy disk or in main memory. It manages the whole process of deciding which blocks should be in memory and which should be returned to secondary storage. It also provides a transaction facility that is the basis of the system's Undo command.

Data-Structuring Software

The data-structuring software (whose structure is shown in figure

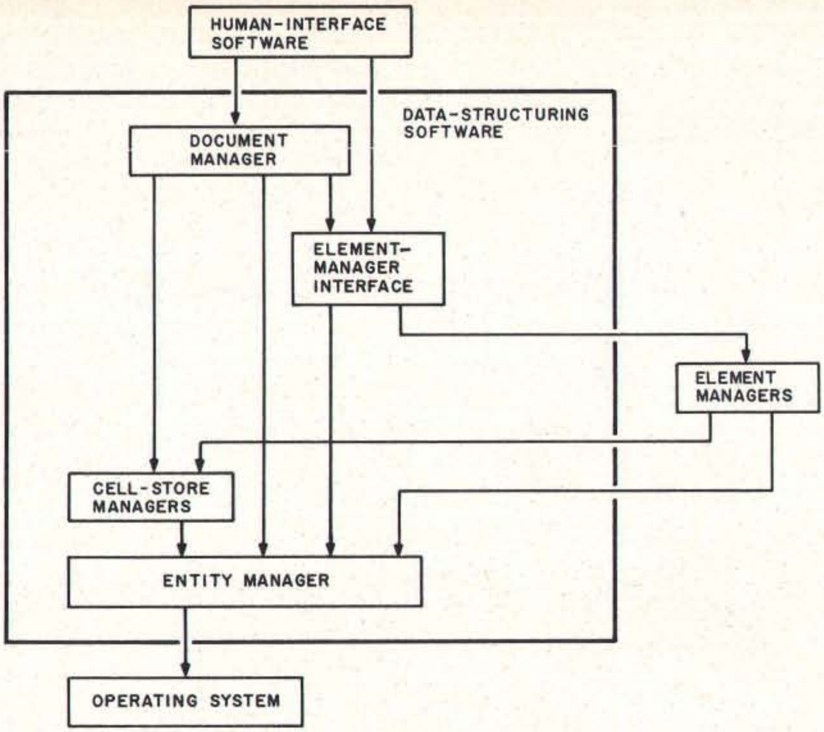

Figure 3: *Details of the data-structuring software, which provides storage for and access to documents.*

3) provides storage for and access to documents. It is built upon the block manager, which provides raw data storage and creates the structures that hold the state of objects. Three principal kinds of objects are supported at this level: documents, elements, and cell stores.

A document can exist on its own on a disk (or in a file drawer, as it is called) and roughly corresponds to what is called a document in the real world: a memo, a paper, a report, etc. A document is made up of a sequence of elements, each of which has a type and corresponds to something like a paragraph, section head, spreadsheet table, form, etc. A document may also contain a number of cell stores.

All documents have the same structure. There can be different types of documents, but these are distinguished principally by the kinds of elements contained in them. For instance, the file drawer, which provides the directory of the contents of a disk, is a special kind of document that can contain only file-folder and document-reference elements.

The second kind of object, an element, has two parts: the storage that holds its state, and a program called an element manager. The state of an object is held in a record-like structure provided by the lowest level of the data-structuring software: the entity manager. One important piece of information kept by the entity manager is the type of the element.

Each type of element (e.g., paragraph, table, etc.) has associated with it an element manager. This element manager implements a standard set of operations that can be performed on an element, such as displaying the element, handling a selection in the element, typing into the element, copying information out of the element, etc. These operations are invoked by the human interface in response to user actions. The element manager performs those parts of the uniform set of user operations that are peculiar to a particular element.

The element-manager interface maps the calls invoking a common operation for an element to the element manager associated with it using the element-type code stored by the entity manager for the element.

The third kind of object supported by the data-structuring software, the

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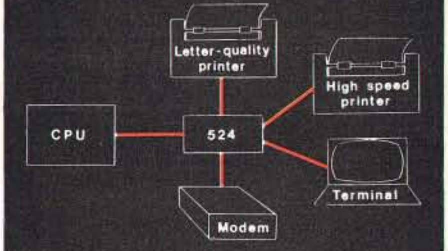

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cell store, holds values that can be displayed by elements and maintains some method of computing those values. Thus, a spreadsheet-table element displays the values of cells in a cell store. The cell store holds the formulas used to calculate the cell's values. Cell values can also come from such sources as a database query or an arbitrary application program, and they can be displayed by any type of element, such as a form or a paragraph. Thus, a paragraph could talk about the results of a spreadsheet, directly displaying cell values from that spreadsheet, or display the results of a query in an address database, thus handling such applications as mail-merging.

Human-Interface Software

The human interface handles all interaction with the user and is responsible for displaying objects and effecting those manipulations on objects that the user requests. The structure of the human-interface software can be viewed in two ways.

The first (figure 4) shows the tasks that run the human-interface software. The highest-priority task is that associated with the desktop view, and this task controls which human interface task has access to the input devices and display. Each of the open documents or file drawers in the system has a task associated with it. When such a task has access to the input devices and display, the user can view and manipulate the associated document and its elements. At any time, the user may press the Desk Top button, activating the desktop task, which takes over the input device and display and which may, at the user's request, cause another task to get the input device and display.

Figure 5 shows the other way of viewing the human-interface software: by its program structure. Each human-interface task executes the program shown in this figure. At the lowest level are the input and display routines that give access to these devices and cause a human-interface task to block if it is not allowed to access the devices when it tries.

Above this are various utility rou-

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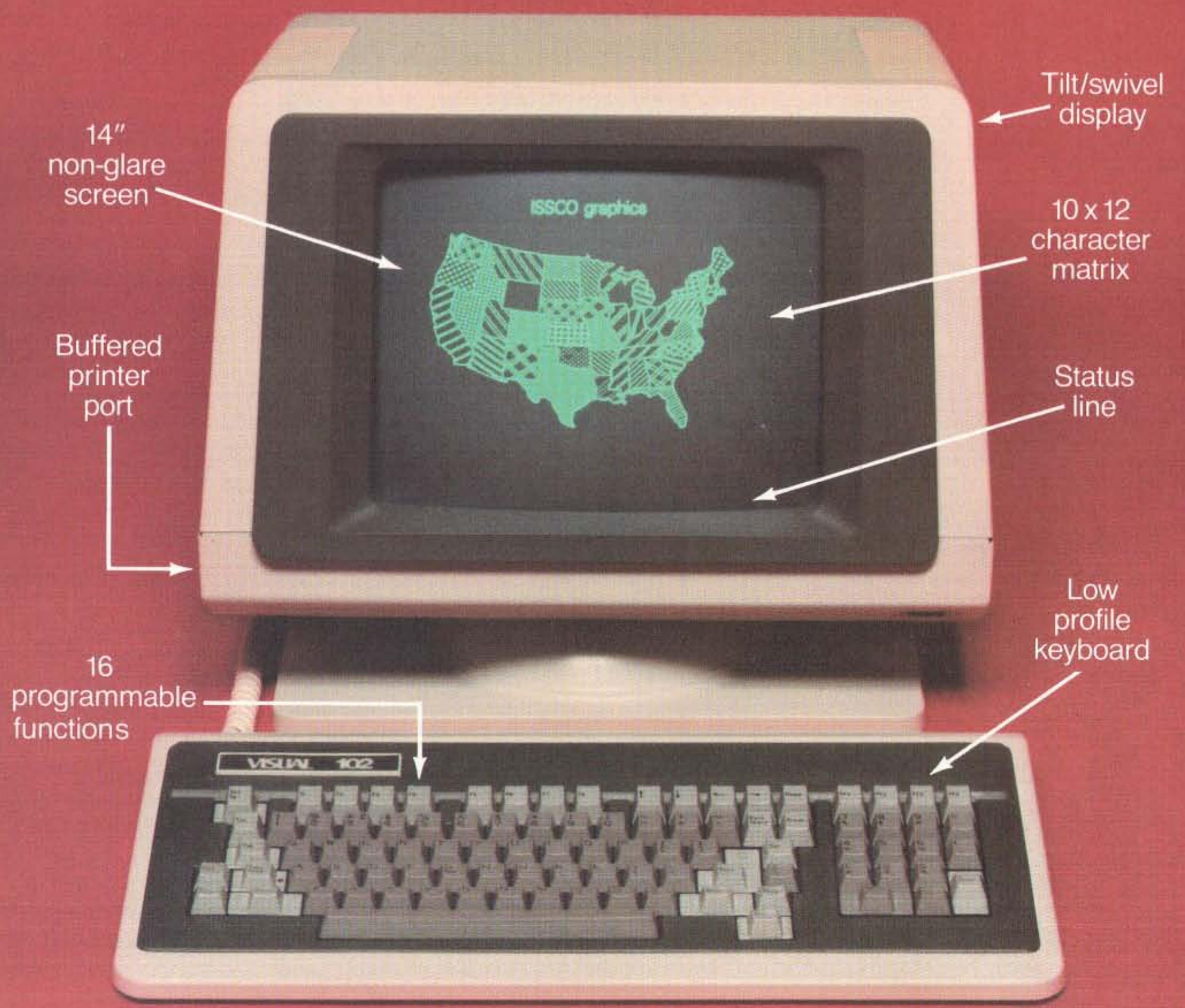

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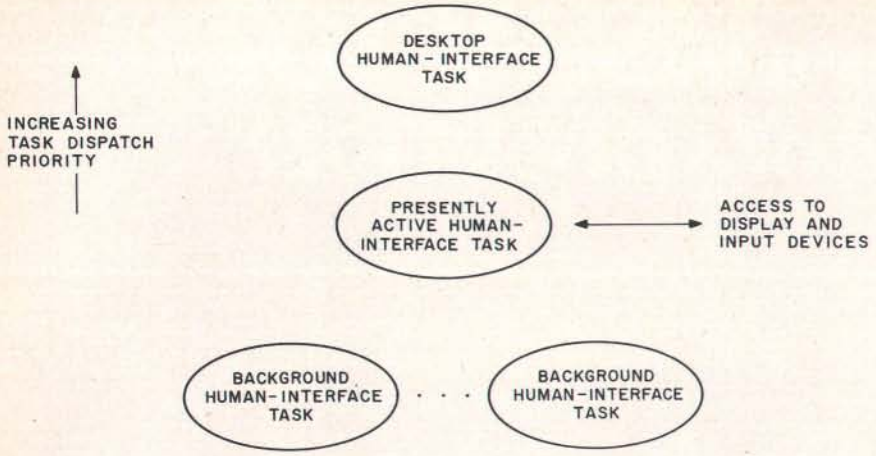
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INCREASING TASK DISPATCH PRIORITY
PRESENTLY ACTIVE HUMAN-INTERFACE TASK
ACCESS TO DISPLAY AND INPUT DEVICES
BACKGROUND HUMAN-INTERFACE TASK
BACKGROUND HUMAN-INTERFACE TASK

Figure 4: *The structure of the tasks that run the human interface.*

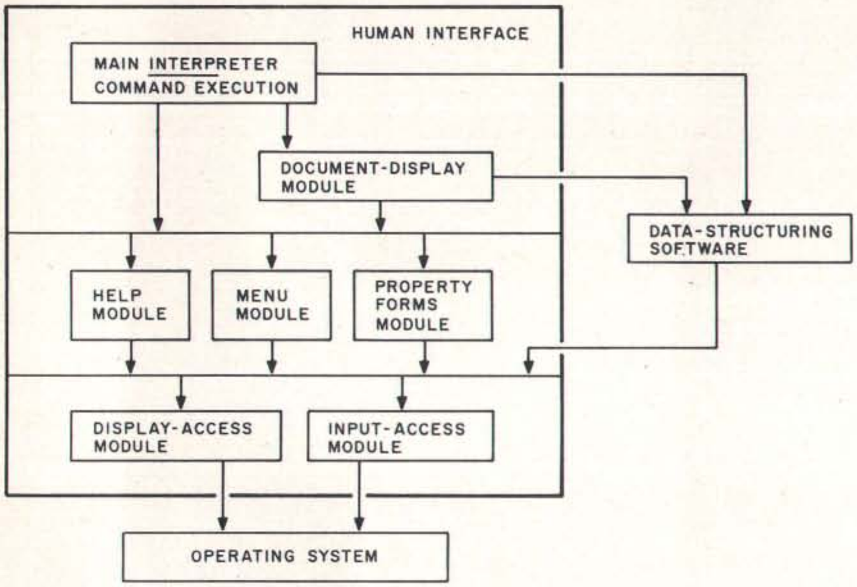


Figure 5: *The components and structure of the human-interface software.*

tines for displaying menus of operations and property forms. Also here is the Help module, which is called on to provide help whenever the user presses the Help button. This module gathers information from its environment and answers any of a set of questions that the user can select, such as "where am I?" "what just happened?" or "what can I do next?"

Next is the document-display module, which has primary responsibility for causing a document and its elements to be displayed. It figures out which elements in a document are to be displayed on what parts of the screen and calls the appropriate entry points in the element managers to cause the elements to be displayed there. This module also remembers what parts of what elements have been selected and handles all movement of the viewing window on a document.

The top part of the human-interface code is the main interpreter, which actually reads the user's actions on the touch pad and keyboard and performs the appropriate action. Note that according to this organization, the central human-interface software is always in control and that the application element managers are only invoked when the human-interface software deems it appropriate. This not only means that common code is concentrated in the human-interface software, it also ensures a uniformity of response, as the user is always dealing with the human interface.

Application Software

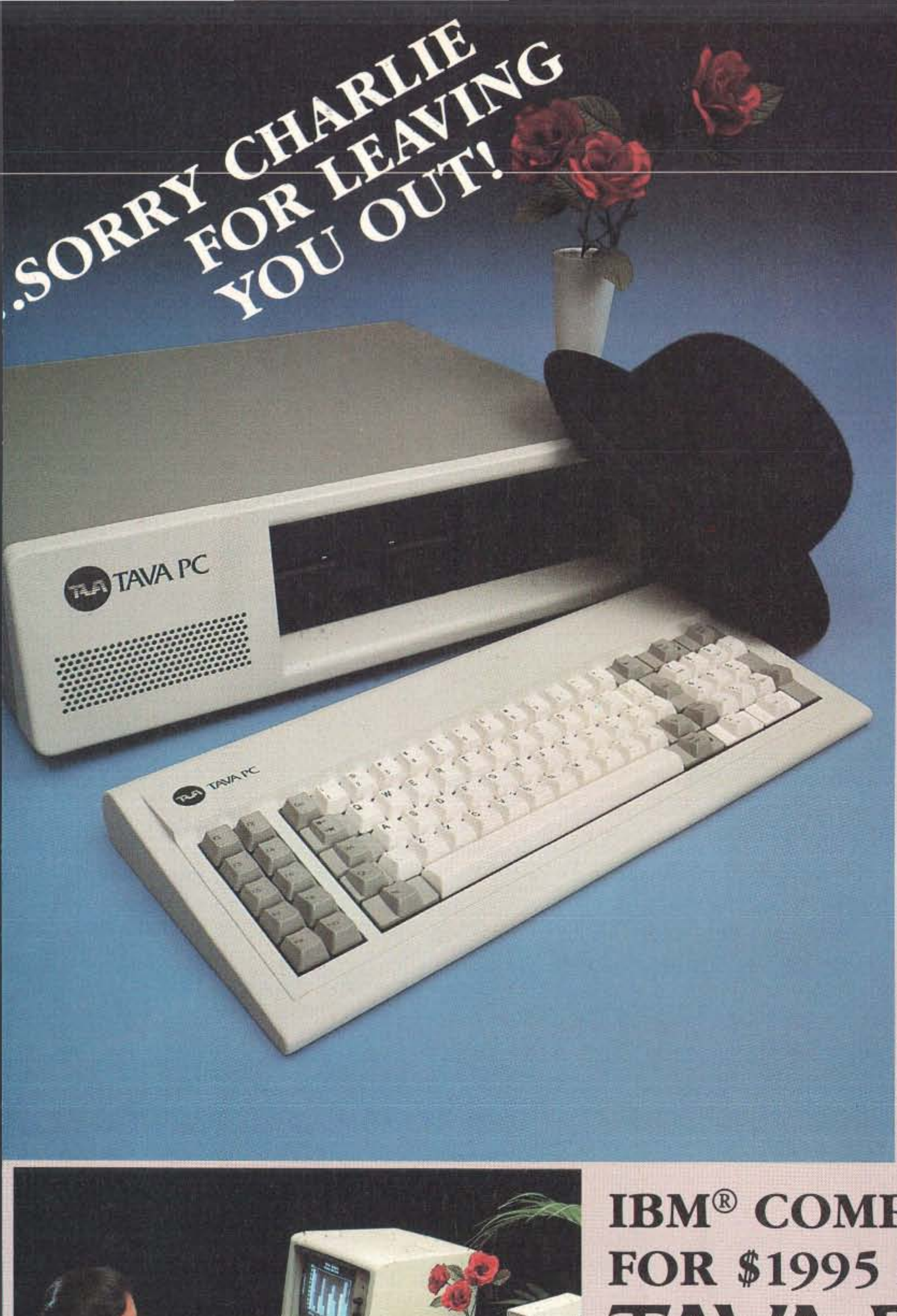
There are basically three ways in which an application can fit into the Gavilan portable computer's software system. The first is as an element manager, and most of Gavilan's applications use this mechanism to interact with the user. Often such applications also involve a cell store.

The second way is as a more conventional application program. In this case the application code is associated with a human-interface task, but it replaces the main interpreter and the document-display module. Although it must still follow the human-interface conventions as to when it has access to the keyboard and display, it has a great deal more freedom about how it interacts with the user. Gavilan's communication and terminal-emulation application is one that follows this style.

The third application style is to interact with the user through a form. In this case the application is associated with a human-interface task that displays a document with form elements in it. The user interacts with the form element manager through the main interpreter of the human interface, viewing and filling out the form. At various times, the user can activate buttons on the form, invoking the applications program. Through a cell store associated with the form, the application can read values from the blanks in the form and write values to other blanks in the form. Thus, a life-insurance application could use a form to gather data about a potential client and then use another form to display net worth and other financial results for the client.

In all cases, the application code can access conventional files held by the data-structuring software, retrieving, updating, and displaying data from these files.■

John Banning is vice-president of software engineering for Gavilan Computer Corporation (240 Hacienda Ave., Campbell, CA 95008).



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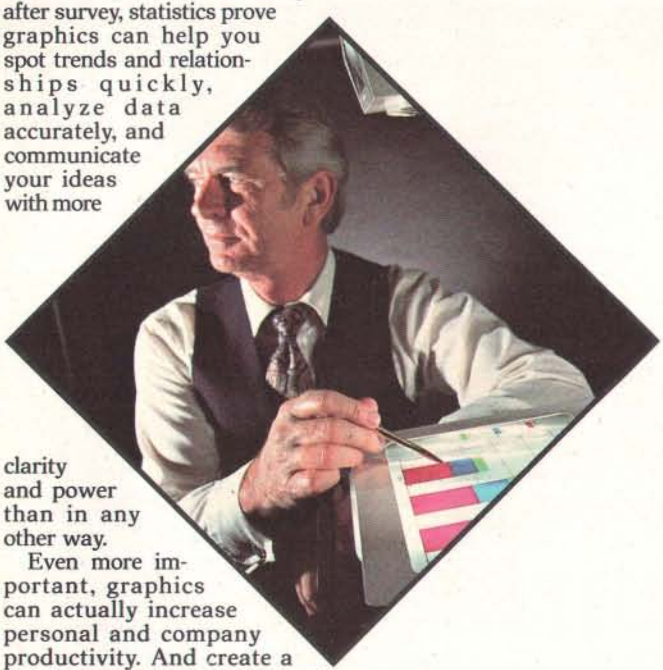

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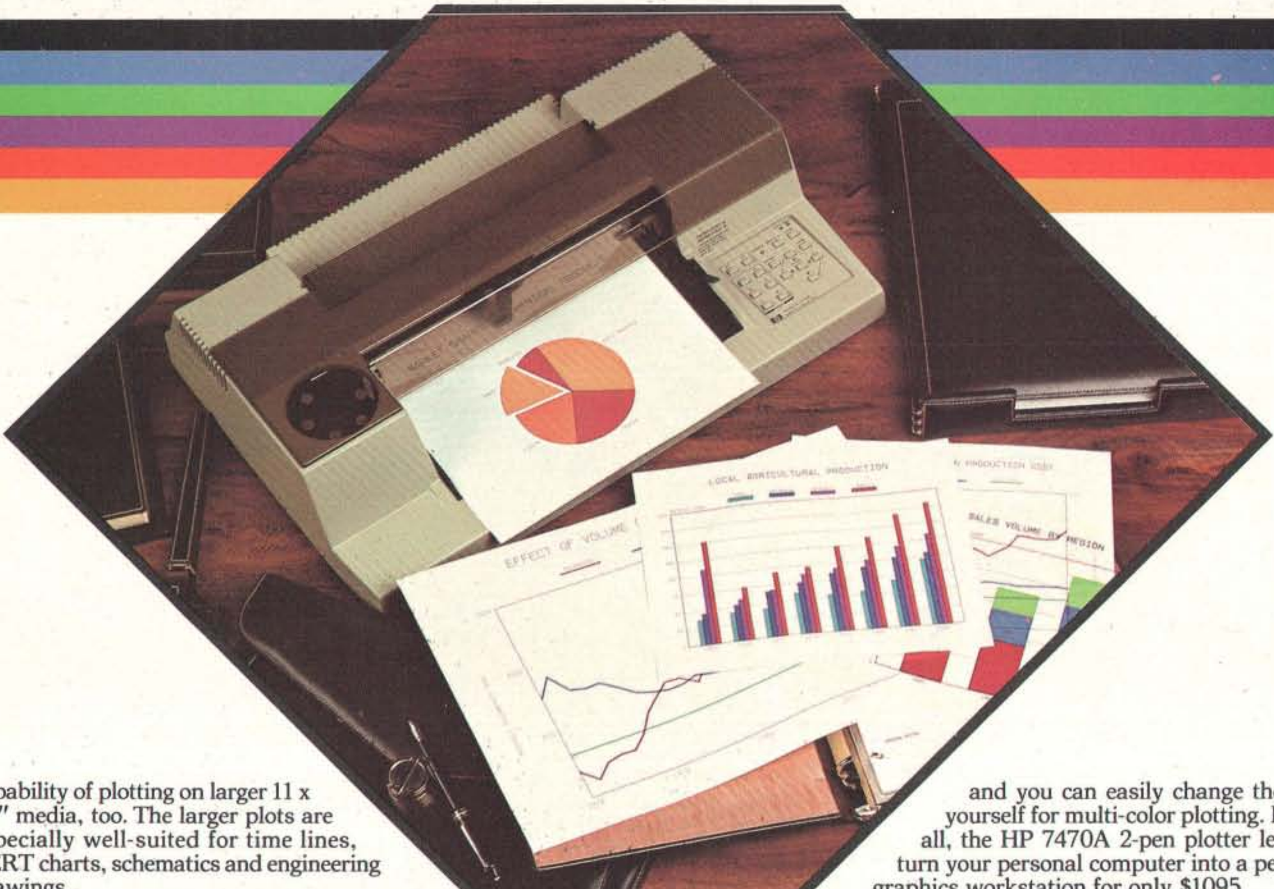

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Reviewer's Notebook

by Rich Malloy

The Chameleon Plus

Last month I mentioned that Seequa Computer Corporation of Annapolis, Maryland, was going to send us a revised version of its low-priced Chameleon. The first unit the company sent us had some difficulty with its serial port and its parallel printer port. In addition, its documentation was somewhat lacking.

This month, I am pleased to report that Seequa has delivered on its promise. We recently received a Chameleon Plus that seems to be in almost perfect working order. The parallel printer port works without a flaw, as does the serial port. And the documentation for the MS-DOS operating system seems as complete as that for any other computer. There are still a few very minor rough edges (we still haven't received MBASIC or the CP/M-80 operating system yet), but this machine looks pretty good.

Note, however, that the Chameleon Plus is not the $1995 system I mentioned last month. The $1995 system has only single-sided disk drives (160K bytes each) and 128K bytes of memory. In contrast, the Chameleon Plus has the more useful double-sided drives (320K bytes each) and 256K bytes of memory. It also costs more—$900 more, to be exact, for a total of $2895. That puts it in the same league with other portable IBM clones from Corona and Columbia and even the slightly higher-priced Compaq. The ace up Seequa's sleeve, however, is its CP/M-80 compatibility, and the real value of the Chameleon will depend on how well the company supports that capability. Look for a detailed review of this machine soon.

On the Printer Scene

As anyone who has been watching the printer market has probably observed, a number of trends appear to be developing. For example, several good quality daisy-wheel printers have been introduced at fairly reasonable prices, and some are even sprouting keyboards. Not to be outdone, more and more electronic typewriters are coming out with computer interfaces. Meanwhile, dot-matrix printers with increasingly high resolution are appearing. A few of these machines have come our way recently.

Comrex, which is part of the Epson family, has been selling daisy-wheel printers for some time, seemingly in competition with the tremendously successful dot-matrix printers made by its parent company. Comrex's latest offer, called the CR-II Comriter, is a variation of the Brother HR-15 printer, and at $599 for a parallel version ($649 for serial), it's a good buy.

The CR-II prints at about 13 characters per second (cps), which seems common for low-cost daisy wheels. It can print at a pitch of either 10, 12, or 15 characters per inch or do proportional spacing, but the proportional spacing requires a special daisy wheel. I've been using the CR-II with letterhead paper and it's been giving me some very nice-looking documents. My only real complaint is that its page-feed mechanism is a bit awkward.

In the dot-matrix category, Mannesmann Tally of Kent, Washington, a division of the giant Mannesmann conglomerate in West Germany, has been quietly producing high-quality printers for some time now. Lately, it has begun producing printers at more reasonable prices.

The latest printer from Mannesmann Tally is called the Spirit-80. About the same size as the Epson MX-80 and priced at $399, the Spirit-80 seems to be a good product for the home market.

The Spirit has one of the best character fonts I've seen on a low-cost dot-matrix printer, thanks to a Mylar ribbon and the use of square print hammers. All of the dots actually connect with each other. It prints at 80 cps. And the choice of pitch is similar to that of the early Epson MX-80: 9, 10, and 17.8 characters per inch.

The TI 855 printer from Texas Instruments is the latest in a line of TI printers. This new dot-matrix printer offers incredibly high resolution at a fairly reasonable price ($935 for friction feed, $995 for tractor feed). In letter-quality mode, each character is composed of an 18- by 32-pixel grid. These characters are almost indistinguishable from typewritten ones. As for speed, the TI 855 prints at 35 cps in letter-quality mode and 150 cps in draft mode.

Perhaps the most interesting feature of the TI 855 is that the character-font generator routines are stored in removable cartridges. These cartridges can be interchanged just like daisy wheels, and three cartridges can be connected at one time. You can switch from regular Courier type to italic type and even to Orator type at the push of a button.

One of the nice little things about the TI 855 is that you don't have to turn the printer off line before you press the page-feed button, which spares you a lot of button pressing.

The TI 855 seems to be a solidly built printer. We've been using it to print out our voluminous manuscripts, and it's been working very well. I only wish we had some graphics software that could take advantage of its high resolution. Maybe next month. ■

Rich Malloy is BYTE's product-review editor.

The Zenith Z-100

This system offers the best of the 8-bit and 16-bit worlds

by Ken Skier

After haunting computer stores and attending computer shows for more than a year, I despaired of ever finding a system that would meet my requirements. What were my requirements? I just wanted the best of both worlds. I needed an 8-bit CP/M system to run the editor and cross-assembler I use in software development, yet I didn't want to lock myself into an 8-bit environment. With all the new software coming out for the IBM PC and its work-alikes, I wanted to be able to run those applications as well. And although I had no immediate need for graphics software, I wanted a system that would support graphics displays because . . . well, just because they're so pretty.

And graphics were what first drew my attention to the Zenith Z-100. I was trudging down yet another aisle at last fall's Northeast Computer Show, hoping that this one might be the last, when an absolutely stunning display of color graphics stopped me in my tracks. "What's this?" I asked the man. "This" was the new computer from Zenith Data Systems, the Z-100. It had just the kind of split personality I was looking for: an 8-bit side consisting of an 8085 running CP/M and a 16-bit side consisting of an 8088 supporting MS-DOS (known as Z-DOS when it runs on the Z-100). Here was one system that seemed to offer me the best of both worlds. And to put the icing on the cake, its color graphics clearly outclassed the IBM PC's.

So I bought it. And I've used it far more than 40 hours a week for the last eight months. After that kind of road test, I can report that I am still impressed by the machine. Let's see why.

Physical Aspects

The Z-100 comes in two basic configurations: the Low-Profile unit and the All-in-One. The All-in-One (photo 1) features a built-in monochrome CRT (cathode-ray tube). The Low-Profile unit lacks a display, but it's only 7 inches high and designed to serve as a base for an external monitor. Both units provide signals for an external RGB (red, green, blue) or monochrome video monitor.

Both units are 19½ inches on a side. The All-in-One is 13½ inches high; the Low-Profile unit, true to its name, stands only 7½ inches tall. Each has room internally for two 5¼-inch floppy-disk drives or for one floppy-disk and one Winchester drive, and each can support one or two external 8-inch drives as well.

Z-100 is enclosed in a "durable earthtone-color cabinet" that has proved quite resistant to smudges and fingermarks. The optional 8-inch floppy-disk system comes in a cabinet of the same color. It would look at home in any business or professional setting.

The Display

The Z-100's text display (photos 2 and 3) consists of 25 rows of 80 characters, each formed from a 5 by 9 dot matrix. The characters are crisp and clean, and the letters g, j, q, and y have true descenders.

Under ZBASIC, text can be displayed in any of eight colors, and all selected colors may be visible on the screen at the same time. By exchanging the foreground and background colors, you can display text in reverse video. Furthermore, ZBASIC gives you control of each pixel on the screen, so you can underline any text or move words and numbers up and down to create superscripted and subscripted text. These display attributes, however, are up to the programmer; they are not built into the operating system.

The Z-100's graphics capability (photo 4) is impressive: 225 rows of 640 pixels. If color memory has been installed, you can assign any of eight colors to any pixel. (An RGB monitor is necessary to do justice to the Z-100's color graphics capability; with a monochrome monitor, you will see only eight levels of gray.) Text and graphics can be displayed on the screen at the same time.

The display is bit-mapped as three planes of color: one 64K-byte plane each for red, green, and blue. Although ZBASIC includes powerful graphics commands and statements, the assembly-language programmer may choose to access the screen directly by reading and

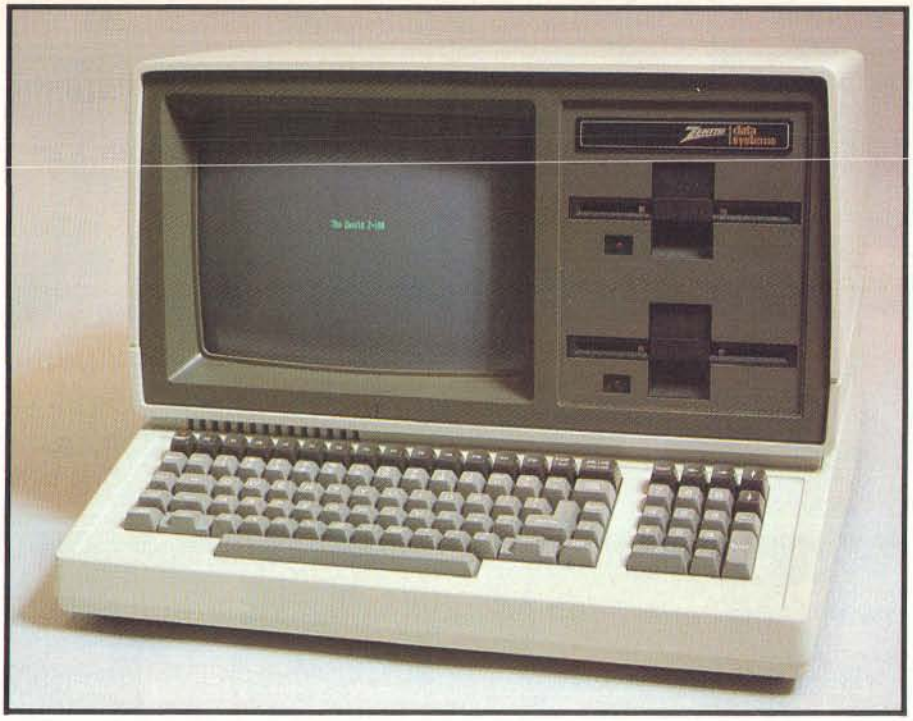


Photo 1: *The Zenith Z-100. This version features a monochrome monitor in All-in-One style. In another configuration, the Low-Profile style, the monitor is in a separate enclosure and the disk drives are arranged horizontally above the keyboard. An RGB color monitor is available for both styles. Note that the keyboard has an IBM Selectric-style key layout, with a numeric keypad on the right and a row of function keys along the top.*

writing the appropriate bytes in memory.

The Keyboard

The keyboard is one of the great strengths of the Z-100. It consists of a standard typewriter keyboard bordered on both sides by such frequently used keys as Control, Help, and Delete, and topped by a row of 13 programmable function keys. To the right is a keypad of numeric and cursor keys. There are 95 keys in all.

The keyboard has the feel of a Selectric typewriter or dedicated word processor. The keys are nicely sculpted, travel about an eighth of an inch, and bottom out positively. They are also extremely reliable. I am not a gentle typist. (In my last job, I had to have my dedicated word-processing keyboard replaced every few months.) Yet the Z-100 has stood up now under eight months of my hammer-handed typing and never missed a key.

The typewriter keyboard itself has an absolutely conventional, Selectric-style layout. The Shift keys are where you would expect them to be, as are the Tab and Return keys. The Tab key is properly oversized, and the Return key is oversized and shaped like a backward "L"—a great big target that you can't miss, no matter how fast or wildly you type.

The 13 programmable function keys in the top row can be assigned any function quite readily in ZBASIC (a version of Microsoft BASIC almost identical to IBM's BASICA). A special Help key can be used by programmers to make their programs self-documenting, but not all applications programs take advantage of this key. Those that do, of course, are much easier to use than those that don't. Someday . . . ah, someday every computer will have a Help key, and every program will take advantage of it.

All keys repeat automatically if held down. The normal repeat rate is 11 characters per second, but by holding down the Fast Repeat key, you can make any key repeat at 28 characters per second. I find this feature tremendously convenient, especially when I want to space halfway across the screen or enter a row of asterisks into a program.

Like many dedicated word processors, the Z-100 clicks to acknowledge each keystroke. I like getting this confirmation, but if you find it distracting, you can type an escape sequence (described in the Z-100's excellent documentation) to suppress the key-click.

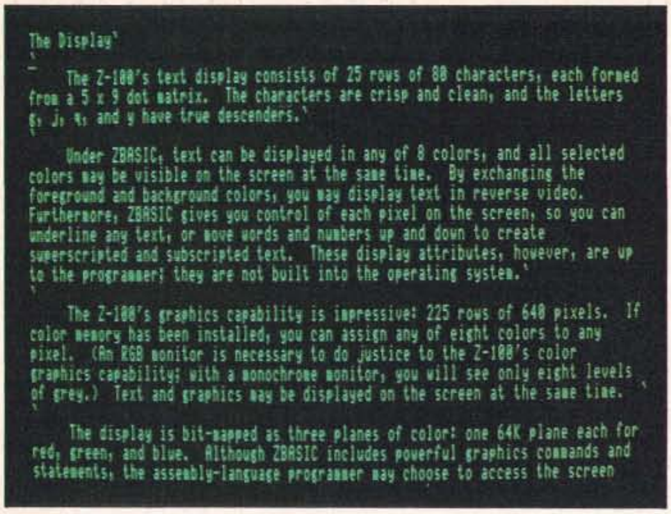
Part of the numeric keypad is a dedicated cursor pad. Its layout is usable but less than ideal. If the cursor keys were laid out in a diamond pattern, they would be easier to use. They would also take up more space, but I would willingly sacrifice the numeric pad for a diamond-shaped cursor pad. Or Zenith could make the Z-100 a little wider, to make space for a diamond-shaped cursor pad and a numeric pad.

Disk Drives

As I mentioned before, the Z-100 has room internally for two 5¼-inch floppy-disk drives or for one 5¼-inch and one Winchester drive; it can also support one or two external 8-inch drives.

The 5¼-inch floppy-disk drives hold 320K bytes of data (formatted) and are compatible with the IBM PC's drives. Thus, you can create a file on a Z-100 (running Z-DOS) and save it on a floppy disk, then carry that disk over to an IBM PC (running PC-DOS) and access that file. (However, although Z-100 disks are compatible with IBM PC disks, that doesn't mean that you can save a program on one machine and run it on the other. More on that later.)

My main concern in dealing with any disk drive is its



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The Display`
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`
     The display is bit-mapped as three planes of color: one 64K plane each for
red, green, and blue.  Although ZBASIC includes powerful graphics commands and
statements, the assembly-language programmer may choose to access the screen
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Photo 2: *An example of text on the Z-100's monochrome display.*

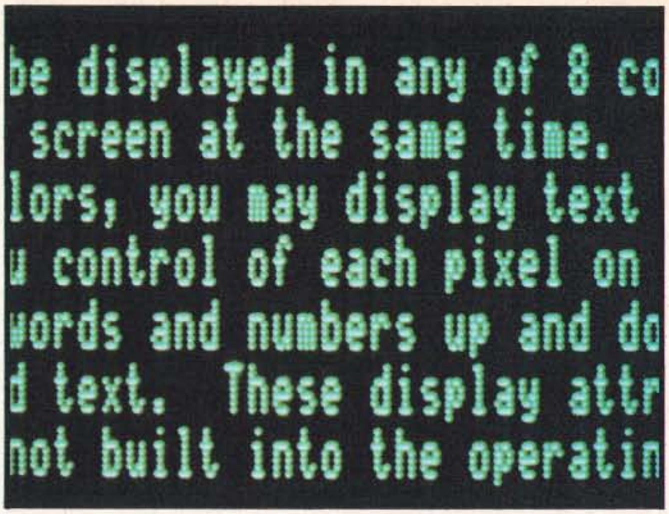

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Photo 3: *A close-up of text on the Z-100's monochrome display.*

reliability. The 5¼-inch floppy-disk drives on the Z-100 have proved themselves reliable beyond my wildest expectations. In the first six months of very heavy use, the drives performed flawlessly. (I even had disks survive power outages—with no loss of data!) However, I did encounter some disk errors when I persisted in using the Z-100 during periods of extremely hot, muggy weather. (Installing an air conditioner and cleaning the heads solved that problem.)

Unfortunately, 8-bit CP/M software is hard to come by in the Z-100 5¼-inch format. I've resorted to buying it on 8-inch disks and having my dealer transfer files from the 8-inch disk to a Z-100 floppy disk. Or, if you have access to a Kaypro, you can use it to transfer files from many common 5¼-inch formats to the Z-100 format. (Of course, if the Kaypro can do it, why can't the Z-100? If the Z-100 could read assorted 5¼-inch formats, I'd have a much easier time acquiring software. How about it, Zenith?)

The optional 8-inch disk system includes one drive ($1599) or two drives ($2299) and stores 1.25 megabytes on each disk. The advantages of this system include—obviously—much more data storage on line as well as faster disk access and the ability to buy software in the

At a Glance

Name
Zenith Z-100

Manufacturer
Zenith Data Systems Inc.
1000 Milwaukee Ave.
Glenview, IL 60025

Components
Size: 19.5 by 19 by 7.5 inches
Processors: 8085, 8-bit, 5 MHz; 8088, 16-bit, 5 MHz
Memory: 128K bytes system memory (expandable to 768K), plus three 64K-byte planes of screen memory; all parity-checked

Display
Text: 25 rows of 80 characters, 5 by 9 dot matrix ("soft" character set, dynamically redefinable)
Graphics: 225 rows by 640 dots; 8 colors
Output: RGB and monochrome video

Keyboard
95 keys, including 13 user-programmable function keys and an 18-key numeric and cursor pad
Repeat rate: 11 characters/second; with Fast Repeat key: 28 characters/second

Mass Storage
Two internal 5¼-inch floppy-disk drives, double-sided, 320K, IBM PC-compatible; controller supports two external 8-inch drives as well; optional 11-megabyte Winchester may replace one of the internal drives

I/O
Two EIA RS-232C serial interface ports, software-configurable for 110 to 38,400 bps; one 8-bit Centronics-compatible parallel port (output only)

Expansion
Bus provides five IEEE-696 (S-100) slots; disk controller occupies one

Software
None included; CP/M-85 and Z-DOS (MS-DOS) are available, as are 8-bit MBASIC, 16-bit ZBASIC, 1-2-3, Microplan, Wordstar, Peachtext 5000, and other programs

Options
The Z-100 is available with 0, 1, or 2 built-in 5¼-inch drives; with or without a built-in monochrome monitor; assembled and tested (as the Z-100) or in kit form (as the Heathkit H-100). Software package of Z-DOS, CP/M-85, ZBASIC, and MBASIC available for $300

Documentation
278-page **User's Manual**. Two ring-bound manuals accompany each of the following software products: Z-DOS, ZBASIC, CP/M-85, MBASIC, and Multiplan

Price
Prices range from $2199 for the HS-100-31 (kit with one drive, 192K RAM, monochrome graphics) to $3499 for the ZF-110-22 (assembled unit with two drives, 128K RAM, color graphics) to $5599 for the ZW-120-32 (assembled unit with one floppy-disk drive and one Winchester, 192K RAM, monochrome graphics, built-in nonglare green CRT)

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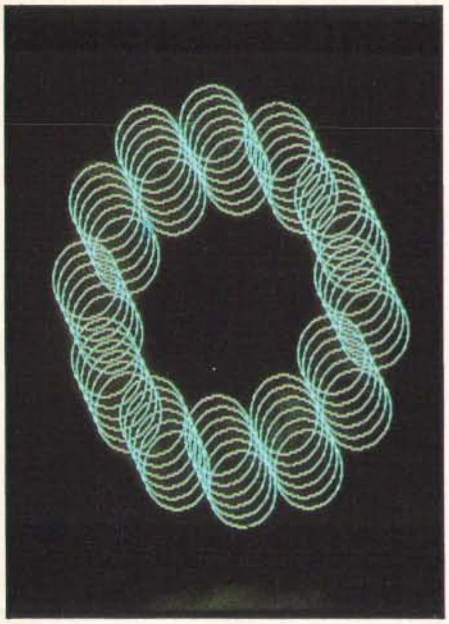

Photo 4: *An example of graphics on the Z-100's monochrome display.*

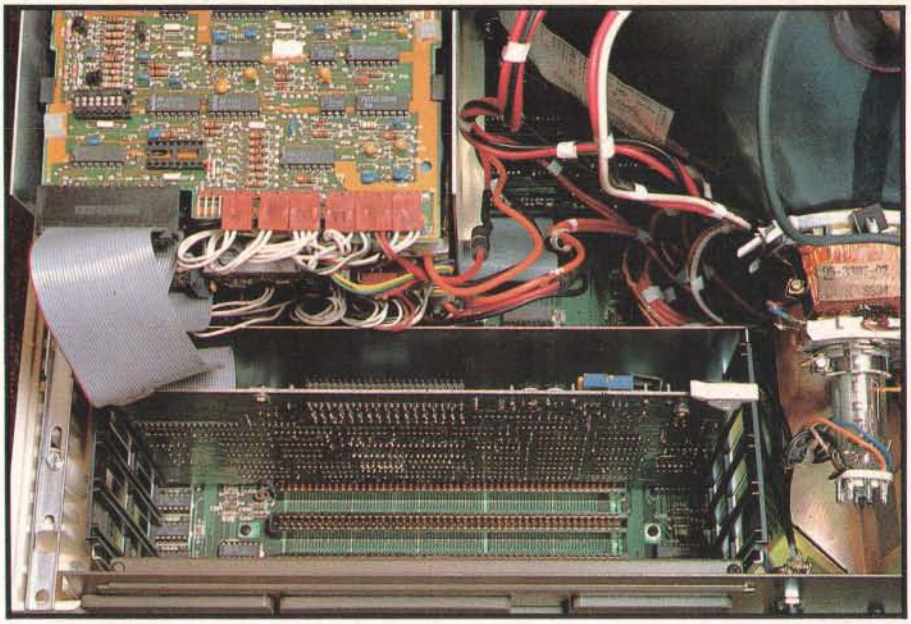

Photo 5: *Inside the Z-100. The S-100 bus sits behind the disk drives and disk-drive controller (upper left) and the display (upper right). Access to this bus is very simple. The top cover of the machine can be easily removed, without unfastening any screws.*

8-inch format.

The optional Winchester drive (about $2400) provides 11 megabytes on line, which may be transferred to or from the Z-100 at 5 megabytes per second—an order of magnitude faster than the 5¼-inch floppy-disk drives can manage. That's invaluable if you have a large amount of data, or many programs, on line. Still, you must back up that hard disk eventually, and doing so onto 5¼-inch floppy disks will take some time, since you might need 30 or more disks to complete the operation. Nevertheless, one can hardly fault Zenith for offering a hard disk with so much capacity.

Microprocessors

The Z-100 is a dual-processor system. Its 8-bit 8085 lets it run CP/M-85 applications, and its 16-bit 8088 lets it run MS-DOS. Both processors run at 5 MHz.

Note that, although both processors are present, you cannot use them simultaneously, and I am not aware of any applications that transfer control from one processor to another. Thus, in any given work session, the Z-100 is either an 8-bit system or a 16-bit system.

How do you tell the Z-100 which processor to use? Just turn it on and insert the appropriate system disk. If you insert a CP/M-85 disk, the Z-100 will configure itself as an 8-bit, CP/M system. Or cold-start it with a Z-DOS disk, and the Z-100 will configure itself as a 16-bit, MS-DOS system.

Memory

The Z-100 is available with as little as 128K bytes of RAM or as much as 768K, all parity-checked. The main circuit board can accommodate 192K bytes of RAM; additional memory requires memory cards, which plug into the S-100 bus (photo 5).

(With all this RAM on hand, you might want to use some of it as a RAM disk—or, in the 8-bit environment, you might want to access memory beyond 64K through the use of bank-switching. If so, you'll have to look to third-party software developers, since the software supplied by Zenith provides neither RAM-disk capability nor bank-switching.)

In addition to the system RAM just described, the Z-100 contains 64K to 192K bytes of video RAM. Monochrome graphics needs only 64K, whereas color graphics requires 192K: three planes of 64K each, to provide information for the red, green, and blue signals. A Z-100 with only monochrome graphics can be upgraded to color by the addition of 128K bytes of RAM (a $290 option).

Interfaces

The Z-100 comes with two serial ports, a parallel printer port, a light-pen interface, and outputs to drive RGB and composite video monitors. Sockets for all of these interfaces are on the back of the Z-100 (photo 6), making it easy to have a very neat installation, with all cables out of sight.

The serial ports conform to the EIA (Electronic Industries Association) RS-232C standard. One is wired as DTE (data terminal equipment) and the other as DCE (data communications equipment). Thus, one or the other should be suitable for cabling to almost any RS-232C device.

By running a program called Configur, you may set each serial port to any desired data rate, from 110 to 38,400 bits per second. Configur also lets you designate odd, even, or no parity; handshaking protocol, if any; and handshaking pin, if any. Configur is totally menu-driven and extremely easy to use—it even draws a picture on the screen, showing the back of the Z-100, with

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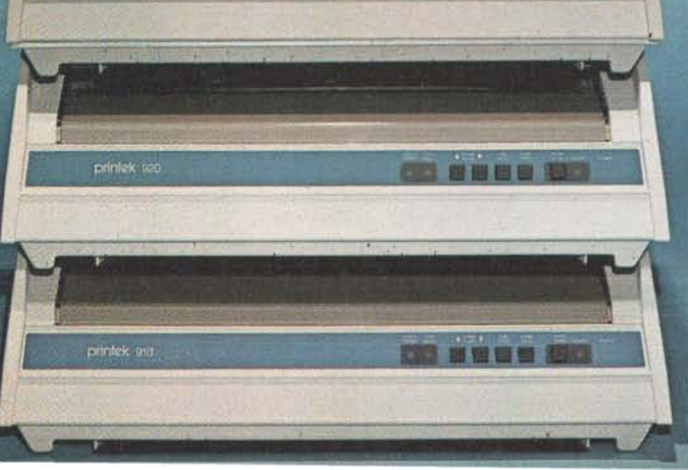

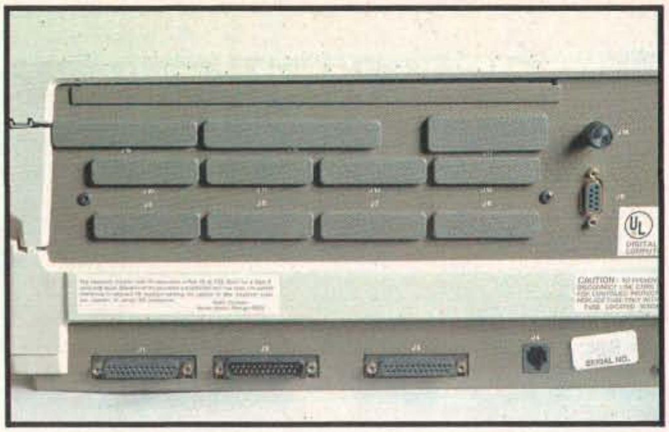

Photo 6: *Part of the back panel of the Z-100. Along the bottom are two serial connectors (both male and female), a parallel printer port, and a light-pen connector. On the upper right is a brightness control for the internal display, just above a connector for an RGB monitor. Note the wealth of cut-outs for optional connectors.*

an arrow pointing out the DB-25 connector for the port you've selected. The only way it could be more user-friendly is if it had hands coming out of the screen to plug in your cable for you.

I have connected my Z-100 to a variety of computers, printers, and other RS-232C devices, both for input and for output, and have always found the interfacing to be quick and easy. Would that RS-232C communications could always be established so readily.

The Z-100 also features a Centronics-compatible parallel port, making it a simple matter to connect the Z-100 to any parallel-interface printer, plotter, or similar device.

A light-pen port is available, but Zenith does not yet provide a light pen to go with it.

Signals are available for both RGB and composite video monitors. You can drive both types of monitors at once, but both will show the same picture; you can't show one picture on one monitor and a different picture on the other.

If you need more I/O (input/output) than this, you can always plug in an S-100 card to provide the number and type of ports you need.

Software

The Z-100 runs 8-bit CP/M and 16-bit MS-DOS—probably the two most popular operating systems for today's personal computers. A powerful version of Microsoft BASIC is available for each operating system: MBASIC for CP/M, and ZBASIC for MS-DOS.

ZBASIC is almost identical to BASICA, the most powerful version of BASIC available for the IBM PC. They seem to differ only in some of the graphics statements. ZBASIC offers greater resolution and more colors than BASICA, but BASICA offers several screen "pages," whereas ZBASIC offers only one.

I prefer ZBASIC. With BASICA, you must decide at the outset whether you want a high-resolution, monochrome display, or a low-resolution, four-color display. With the Z-100, that decision is unnecessary. All text and

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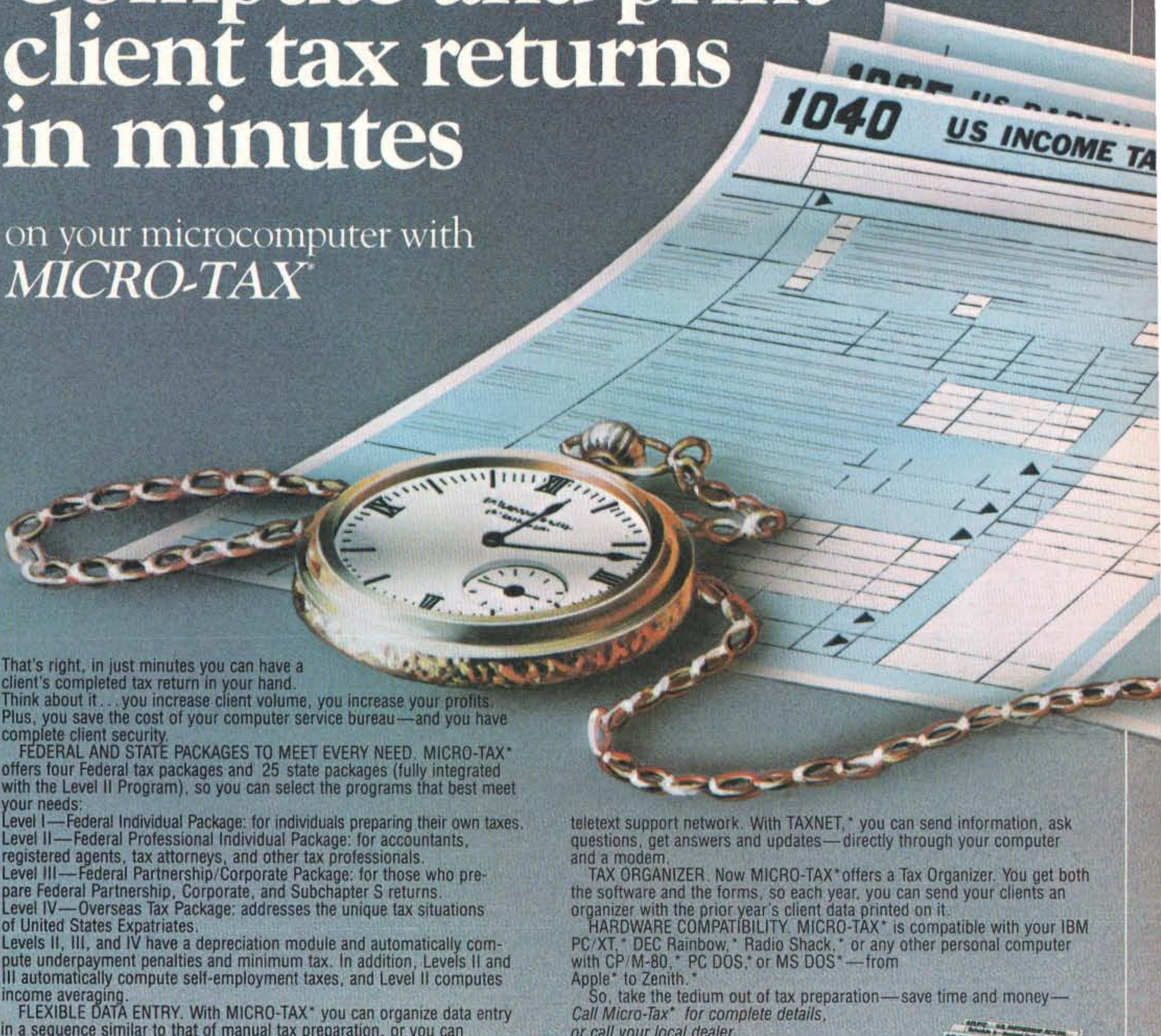

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graphics are displayed in high-resolution mode. There is no need to issue a SCREEN statement to configure the screen; you may PRINT, DRAW, PAINT, or create a LINE in any of eight colors at any time.

With the exception of the graphics and certain parameters used in opening RS-232C ports, BASICA and ZBASIC seem to be identical. Almost any program written in BASIC for the PC should run on the Z-100, with little or no modification. (Of course, if it uses PEEKS, POKES, CALLS, and USR functions, all bets are off.) Nonetheless, you cannot simply take a disk that has an IBM PC BASIC program, insert it into a Z-100, and run it. It won't work, and when you list the program, it won't look right. Why not?

The answer has to do with the way each version of BASIC tokenizes a BASIC program. (A token is a byte used by the BASIC interpreter to represent a keyword. Tokenizing a BASIC program makes it take up much less space in memory or on disk.) A program in memory is always tokenized.

When you save a program on disk, it is normally saved in tokenized form. But BASICA and ZBASIC use different tokens to represent the same keywords. For example, BASICA might use the token \$8A to represent the keyword PRINT, while ZBASIC might use the token \$A2 to represent the same keyword. If you save a BASICA program in tokenized form and then load it into the Z-100, ZBASIC will interpret it as a different program. Every PRINT statement, for example, might be interpreted as a GOTO. No wonder the program won't run.

Fortunately, there is a simple solution. To transfer an IBM PC program to the Z-100, first save it in ASCII (American National Standard Code for Information Interchange) format. (A program saved in ASCII format has all keywords spelled out; they are not represented by tokens.) To save a program in ASCII format, use the optional argument [,A] like this:

```
SAVE "PROGRAM.BAS",A
```

Now you can take the disk over to a Z-100 and load the program. ZBASIC will interpret every PRINT statement as a PRINT statement and will correctly interpret all other keywords as well. Then if the program doesn't run immediately, it should be a relatively simple matter to modify it to make it run.

What about applications programs? Some of the most popular applications for the IBM PC are already available for the Z-100: 1-2-3, Multiplan, Wordstar, and Peachtext 5000, to name a few. And as new products are announced for the PC, their developers often state the intention of bringing out a version for the Z-100. However, the Z-100 is not totally PC-compatible, so don't expect any arbitrary PC application to run on the Z-100 right out of the box. Some will, some won't. That's probably the most frustrating thing about the Z-100. I think it's a better machine than the PC, but sometimes I just wish it were a PC, so I wouldn't have to wonder about its ability to run PC applications.

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Documentation

The documentation provided with the Z-100 is complete and easy to use. It is also voluminous. Printed on 8½- by 11-inch card stock and bound in a vinyl-clad 3-ring binder, each manual outweighs a typical lap computer—and a complete system may well include 10 manuals. (The Z-100 itself comes with a 278-page *User's Manual*, and each software product comes with one or two volumes of ring-bound documentation.) If you get a Z-100 with two operating systems, two versions of BASIC, and Multiplan (a standard software bundle), you'll need a bookshelf just for your system's manuals. And a strong bookshelf, at that.

The *User's Manual* includes many pictures identifying the parts of the system and step-by-step instructions showing the novice how to get the system up and running. The CP/M guide is the best-organized book I have come across on how to use CP/M. Every manual features a table of contents and an index: both are complete and detailed.

Technical Support

When I needed information that I couldn't find in the manuals, I called Zenith's Software Consultation Group. Their performance was excellent. Even when my questions were extremely technical, they managed to give me prompt and accurate answers. Their phone number is printed on the inside of each manual. (No, it's not an 800 number—but the quality of support available at that number is worth far more than the price of the call. Without it, some of my most important applications would never have run on the Z-100.)

Conclusions

The Z-100 is a powerful and reliable system that runs both CP/M and MS-DOS. In many ways it is IBM PC-compatible, but it is not a PC clone and cannot run all PC software. On the other hand, its keyboard and graphics are clearly superior to the PC's.

The Z-100 features sufficient I/O for most applications, and further I/O can be provided via its S-100 bus. Its documentation is excellent and backed up by professional technical support. Quality control in the hardware, software, and documentation is superb. The system delivers exactly what you expect and offers no unpleasant surprises.

How could it be improved? A diamond-shaped cursor pad would help. So would the ability for CP/M-85 to read and write a variety of 5¼-inch disk formats. And although Z-DOS has a utility that can read CP/M files, it can't write them. So I'd like to see a Z-DOS utility that can copy Z-DOS data and text files to CP/M disks.

The bottom line? If you want a well-designed, well-built, well-documented system that runs the best of 8-bit and 16-bit worlds, consider the Zenith Z-100.■

Ken Skier (28 Fairlawn Lane, Lexington, MA 02173) is an author and software developer whose credits include the Skiwriter word processor, now distributed with the Epson Notebook computer.

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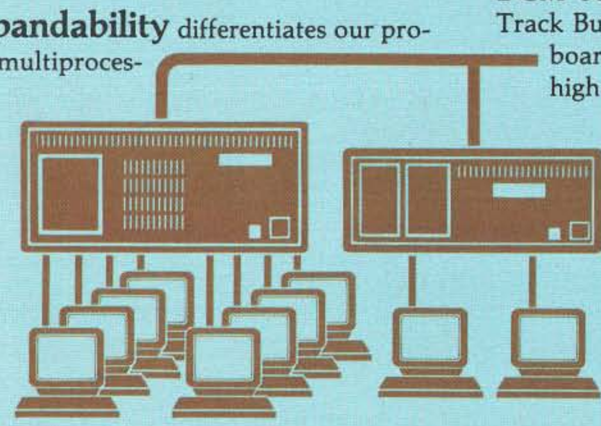

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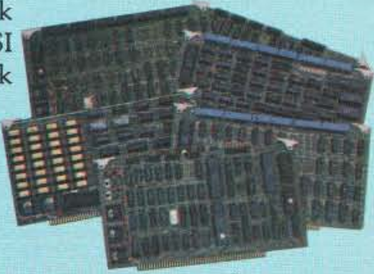

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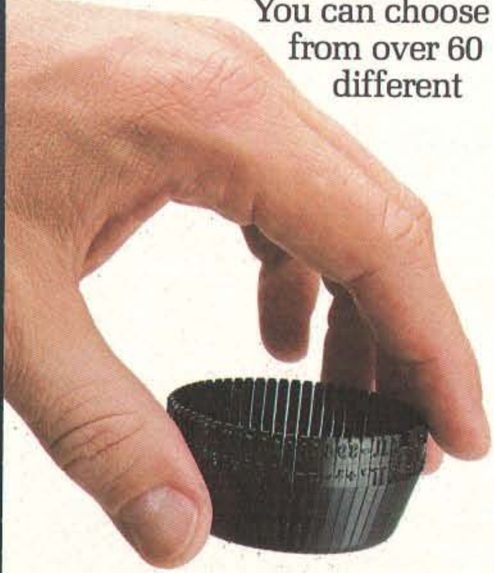

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Pinball Construction Set

Build your own pinball game on an Apple II, Atari 400/800/1200, or Commodore 64

by Elaine Holden

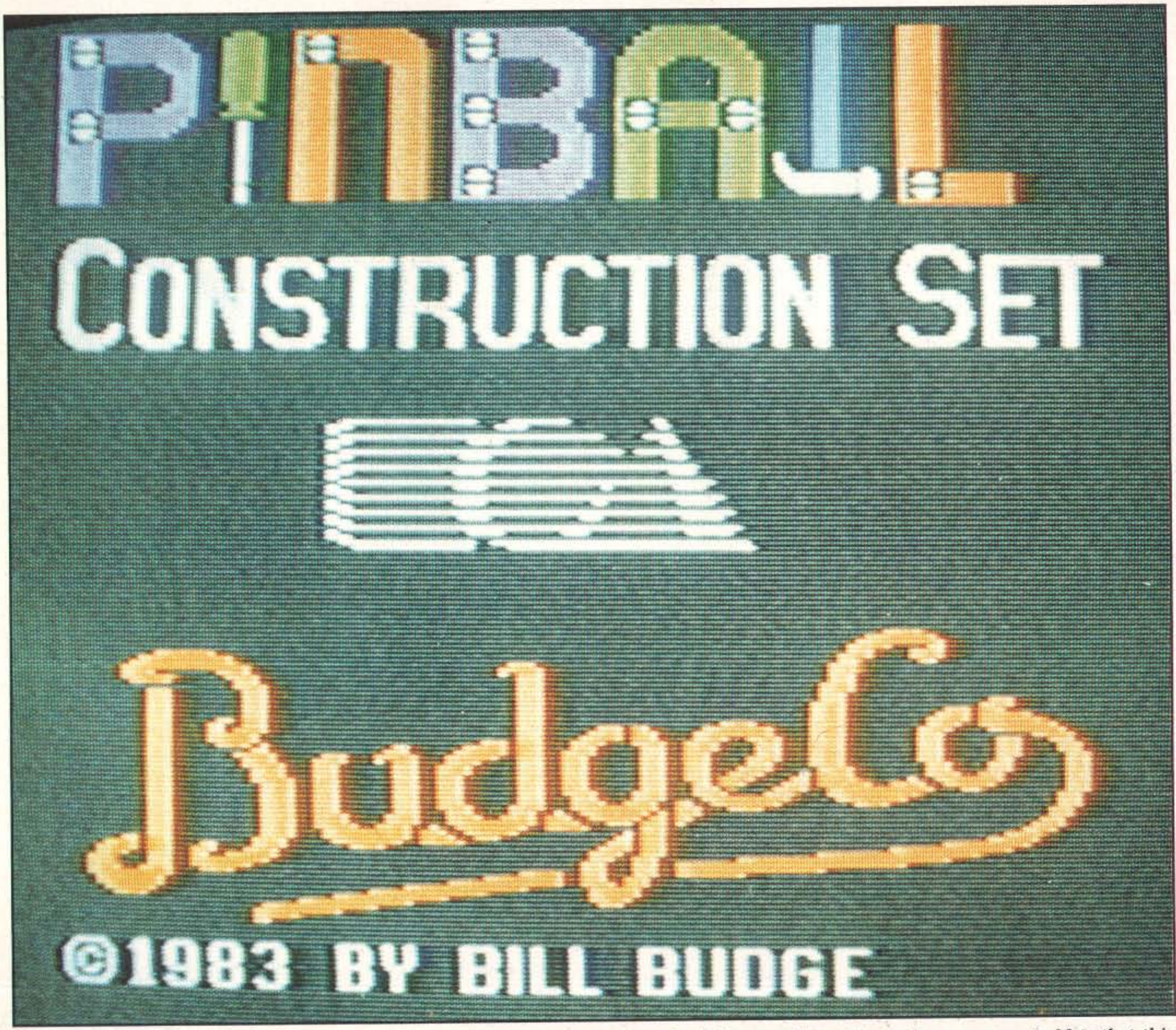

Photo 1: *The title picture for the Pinball Construction Set. This is an example of the type of graphics a player can create. Note that this software was originally published by Budge Company but is now also available from Electronic Arts.*

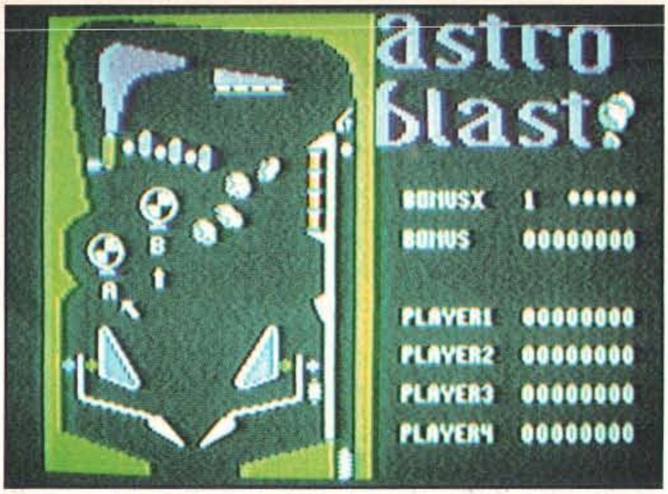

Photo 2: *Astro Blast, one of the demo games that come with the system and are ready to play.*

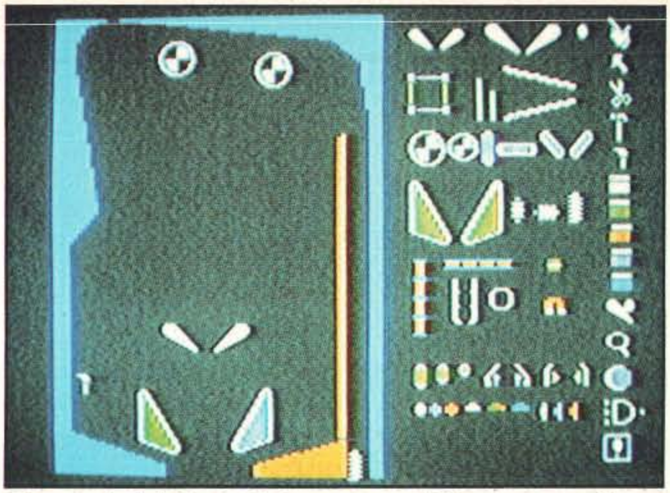

Photo 3: *A pinball game being constructed. Note the menu of game parts on the right half of the screen and the column of icons along the right edge of the screen.*

Attention, pinball wizards! As you well know, those big arcade machines with flashing lights and ringing bells have long been a fascination to those of us wishing to exhibit skill, dexterity, and some evidence of a misspent childhood. Now, thanks to the Pinball Construction Set from Electronic Arts (photo 1), not only can you play pinball in the comfort of your own home, you can also design your own pinball game. Other pinball-simulation games have been available for some time now, but this is one of the first games that lets you build other games.

If you need a game fix immediately after purchase, you can just boot the disk and play one of the five demonstration pinball games available (see photo 2). They are set up for as many as four players, so you can play alone or with friends. After this initial introduction, and once rational thinking has returned, you can reach for the user's guide and discover how much more exciting this construction set can be.

Building a Dream Game

One of my fantasies as a pinball player has always been to build my own game—one to suit my mood. At times I want the toughest challenge going, but once in a while I like a real pushover, and sometimes I even like an honest game. The variety of my requirements is endless, but, until now, the variety of available pinball games was not.

With the Pinball Construction Set, I can make any game I want, save all my quarters, and exercise my creativity at the same time. This game enables a complete novice to put together a worthwhile beginning game, gain experience, and later devise a devilishly tough, highly competitive game.

Just as in any construction kit, all parts are provided. Each piece of the pinball game is represented by a picture. These pieces can be placed anywhere on the empty pinball board (photo 3). All parts are activated and dragged onto the board by a movable hand symbol. This symbol, as well as everything else in the game, is controlled by the joystick.

The Hand is one of a number of icons (pictures) that represent the various functions the program can perform. For example, you work with an icon that looks like a disk to save or load a game. These icons make it easy for a beginner to use the program.

If you want a different shape for a game board, the Arrow, Scissors, and Hammer icons can create and change solid shapes. These are very powerful commands because you can change not only basic shapes within the game's parameters but also the actual shape of the board. (Traditional arcade pinball games, of course, do not offer this option, and I've become bored with the same rectangular shape.) My favorite game creation so far has a pentagonal shape with lots of bumpers and few flippers.

Lest you imagine that the various shapes and games must remain the same color, take heart. A Paintbrush icon instantly changes the color of the game border or the shapes within. (For small shapes there is even a Magnifier icon). If you have a particularly nasty streak, when constructing a game for friends, you can paint over a bumper or other pinball part. It will still be there, you understand, it just won't be visible. To carry this trick one step further, you can paint in what looks like a bumper or paddle, and when the ball falls through the fake part, watch your opponent's face drop.

I also enjoyed personalizing my game with fancy decorations and a nifty title. For this I used the Magnifier icon (photo 4). It takes a little time and patience to perfect this icon's uses. Seeing a part of the screen magnified seven times its usual size takes some getting used to. Persistence is rewarded, however, by some really fine designs and lettering.

I had everything I needed for the perfect pinball game at this point—or so I thought. Then I turned the page of my manual and found the World icon. This feature gives four scales which change the conditions of the ball.

Gravity determines the weight of the ball; Speed governs how fast the ball moves; Kick is the strength of the bumpers; and Elasticity reflects how much bounce is wanted in the game.

The last icon worthy of note is the And gate. An And gate in computer science is a switch arrangement that permits an electrical flow only if all switches in the gate are on. The And gate in the Pinball Construction Set, functioning along the same principle, lets you record a bonus only if all the targets you have hooked together have been hit and turned on. Pretty fancy stuff. This icon also lets you change score values and sound. You can even have the beloved sounds of bells and whistles right at home.

Something for Everyone

I found this to be an incredibly complete kit. Bill Budge, the creator of this package, has a marvelous sense of programming. From the standpoint of an instructor of computer programming, I can only say, "Wow! I wish I wrote that." From the basic concept to the refined details, this is indeed a classy game.

The crowning feature of the Pinball Construction Set is its simplicity. A novice or young child can play a demo game to learn pinball basics. Nevertheless, for adult or child, it needn't remain just a game. Players can exercise creativity with color, shape, sound, relativity of weight and speed, and detail, all with this one program. As expertise increases so does the quality of the games created. Moving at the individual's pace, this non-threatening program records work done and provides for easy correction and alteration.

At a Glance

Name
Pinball Construction Set

Type
Software to play and/or construct a variety of pinball simulation games

Publisher
Electronic Arts
2755 Campus Dr.
San Mateo, CA 94403
(415) 571-7171

Price
$40

Format
5¼-inch floppy disk in Apple II, Atari 400/800/1200 or Commodore 64 formats

Documentation
13-page users guide

Computer Needed
Apple II, Atari 400/800/1200, or Commodore 64; joystick required

Audience
Ages 10 and up: pinball lovers, game players, creative people, and teachers of gifted and talented children

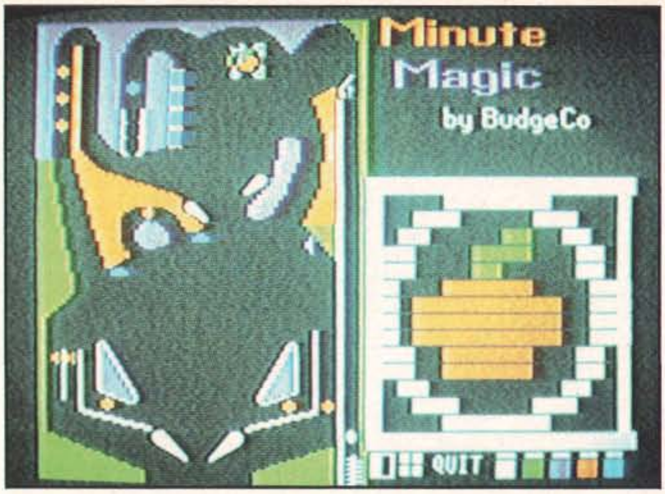

Photo 4: *An example of how the Magnifier icon is used. The figure on the right is a seven-times magnification of the apple in the upper-right corner of the game board.*

Despite this simplicity, sophisticated adult players will also be impressed with the game. It can be difficult enough for even the most advanced player because of the challenge and endless variety of modifications, refinements, and degrees of difficulty available. I predict that this program will be a continuing favorite in many personal game libraries.

I should note that you can also use this program to make gifts for gaming friends. Pinball games of your own creation can be put on blank disks and given away. You can design each game with the recipient in mind, and since up to 128 parts can be on the board at once, hard-core pinball players should remain fascinated for a long time.

Conclusions

It's really hard to find anything wrong with this game. The concept is well designed and executed. The instructions needed to begin the game are minimal, and game playing is immediate and, in the case of novices, instructional. Experienced players can gain valuable tips from the more difficult samples such as DEMO4 and DEMO5 (which illustrate some common obstacles such as a corner of the game where a ball could get stuck).

Creativity is encouraged. At the same time, players are not threatened or intimidated by either the screen display or the user's guide. Rather, they are gently encouraged and aided. This is valuable for children and inexperienced players and computer users.

I certainly feel that the Pinball Construction Set is valuable both as a learning and creating tool and as a truly entertaining game.■

Elaine Holden is the supervisor of reading and language arts for the Merrimack, New Hampshire, School District. She can be reached at 22 Elm Street, Peterborough, NH 03458.

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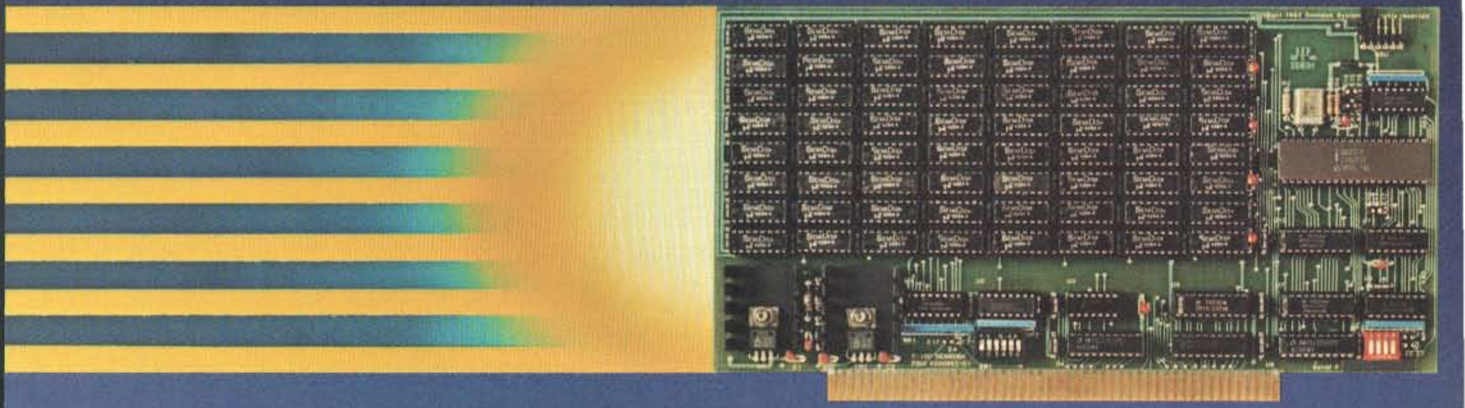

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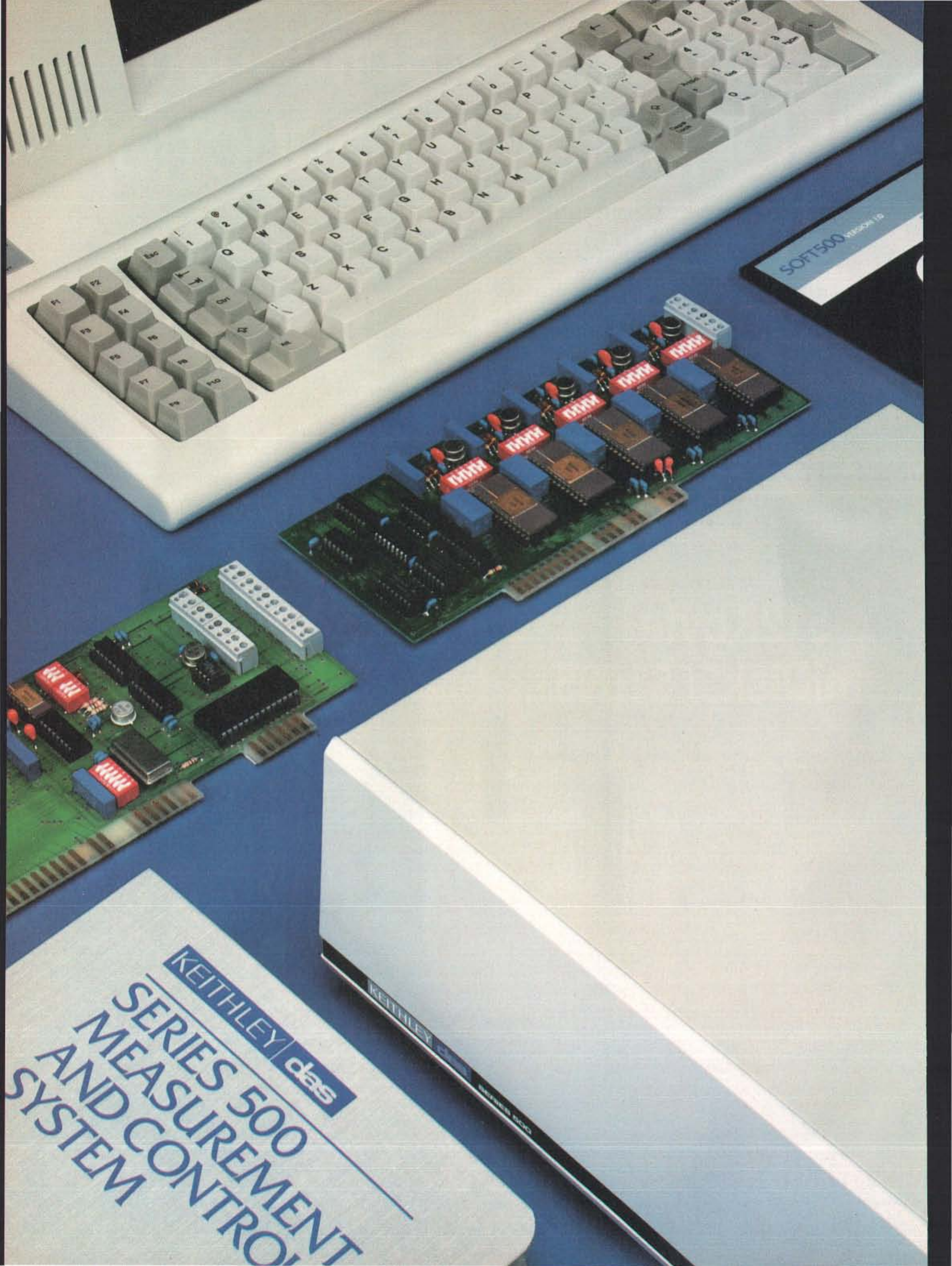
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Instrumentation Amplifier	Yes	+ $700	+ $700	Yes	Yes
± 0.035% Absolute System Accuracy	Yes	+ $1100(4)	+ $1100(4)	No	Yes(5)
30 kHz Sampling	Yes(6)	No	Yes(7)	Yes	No
High Speed Programable Ranges	Yes	No	No	Yes	No
Other I/O					
5 12-Bit Voltage Outputs	Yes	+ $187(8)	+ $937(9)	+ $937(9)	+ $2500(10)
16 Digital Inputs	Yes	Yes	+ $175(11)	+ $330	+ $530
16 Digital Outputs	Yes	Yes	+ $175(11)	+ $350	+ $710
4 120VAC Outputs	Yes	No	No	+ $638(12)	+ $265(13)
System Features					
Programable Timers	Yes	Yes	Yes	Yes	+ $555
Realtime Clock	Yes	Yes	No	Yes	Yes
Power Supply	Yes	+ $350	Yes	Yes	Yes
Software System					
Data Acquisition BASIC	Yes	Yes	Yes	Yes	No
Foreground/Background	Yes	No	Yes(14)	Yes(14)	No
Data Analysis	Yes	No	No	No	No
Realtime Graphing	Yes	Yes	Yes	Yes	No
Engineering Units	Yes	No	No	No	No
Package Price	$4300	$6287	$8037	$6277	$9654

1. System 520. 2. 16 channels of $725 32 channel card. 3. $1640 A/D card plus 16 channels of $580 20 channel card. 4. ± 0.003% accuracy @ 200 Hz. 5. ± 0.006% accuracy @ 40 Hz. 6. Apple system 27 kHz, IBM system 31.4 kHz. 7. 200 kHz option available + $3825. 8. 1 channel from $750 4 channel card. 9. 5 channels from $750 4 channel card. 10. 5 channels from $1000 2 channel card. 11. 16 channels of $350 32 channel card. 12. Price based on 16 channel rack @ $550 plus 4 AC output relays @ $22. 13. Four channels of $525 8 channel card. 14. Or other multi-tasking structure.

Naturally, we'd like to suggest the Series 500 as the wisest choice in workstation data acquisition. But we also believe that as you compare and examine the facts, the Series 500 will eventually suggest itself.

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Circle 123 on inquiry card.

The TRS-80 Model 16B with Xenix

by Steve Barry and Randy Jacobson

The Radio Shack TRS-80 Model 16B is surprising in at least two ways: first, it appeared later than the company's announcements would have indicated, and second, it has an industry-standard multiuser operating system—Microsoft's Xenix, a derivative of Bell Laboratories' Unix version 7. The Model 16B's Xenix capability is remarkable in that it represents the first use of an outside supplier's operating system in Radio Shack's history. This event is of even more interest because Xenix is to be supplied for several other popular microcomputers.

In this review we'll first present an overview of the 16B's hardware and capabilities, and, because the hardware's effectiveness depends on its ability to run Xenix, we'll also cover that operating system's major features.

The TRS-80 Model 16B is a blend of the old and the new. It is based on a dual-processor architecture (Motorola 68000 and Zilog Z80), and it runs as either a single-user or a multiuser computer. The machine is particularly significant because it has most of the hardware features available on other machines in the $5000 to $16,000 price bracket, and it has the support of an industry powerhouse behind it. Although not innovative in concept, the 16B is more than just a solid high-end engine for Radio Shack's software. The computer performs well for its class of machine and is likely to be a major focus of software houses trying to take advantage of Radio Shack's marketing clout and Xenix program portability. The 16B is compatible with an extensive line of Radio Shack peripheral hardware, and there is also a strong indication that the Model 16B will be a central element in Radio Shack's announced but unmarketed local-area-network (LAN) strategy. Indeed, with its LAN-capability option, the system could become the backbone of an expandable, low-cost, office-wide, multimodel, shared-computer resource.

Background

Starting about a year ago, rumors of Radio Shack's new high-end machine piqued the curiosity of many enthusiasts. The computer was supposed to be a powerful yet inexpensive multiuser machine that employed a proprietary operating system said to be incompatible with the software available on widely distributed multiuser operating systems such as MP/M. When the machine failed to materialize, rumors said its delay was due to myriad hardware and software problems.

In spite of its uncertain beginnings, the Radio Shack TRS-80 Model 16B has hit that all important and all too narrow marketing "window," defined by public acceptance of a combination of price, performance, and features. Once such a window is filled by a few machines, other manufacturers find it difficult to penetrate the market. The target market for this machine is the small business that requires a one-source supplier of multiuser turnkey hardware, software, and service for core business applications. However, the 16B can also serve as a small Unix and Xenix development environment.

Photo 1: *The TRS-80 Model 16B standard system.*

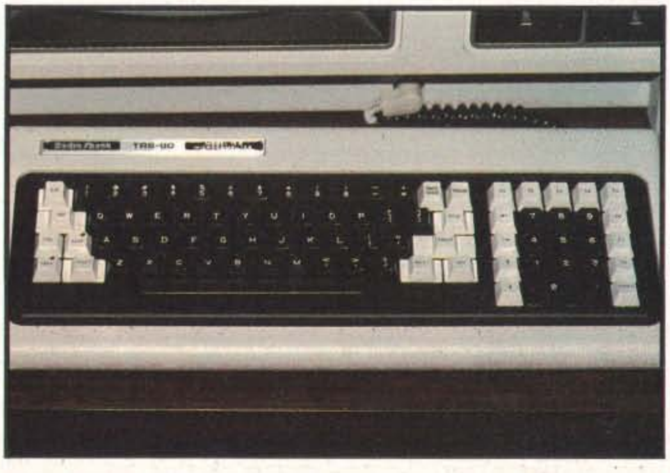

Photo 2: *The 86-key detachable keyboard of the 16B.*

System Summary

The Model 16B (photo 1) runs a large library of single-user software. Moreover, it has multiuser capabilities, and significant multiuser software has become available early in the machine's life (see the At a Glance box).

A minimum three-user system consists of the console with 384K bytes of memory, one 1.25-megabyte 8-inch floppy-disk drive, an 11.6-megabyte hard-disk drive, two user terminals, a printer, and software. The system console has a detached 86-key keyboard (photo 2). The keytops are textured to avoid glare. The standard alphabet, number, and symbol keys and the numeric keypad keys are black with white legends. Other keys—including Shift, Tab, Break, Backspace, eight function keys, and the cursor keys—are white with black legends. A bump is placed on the numeric pad's 5 key to aid manual orientation for touch-typing. Cursor keys are arranged (awkwardly, in our opinion) in a vertical column on the left border of the numeric pad. Keytops are slightly longer vertically than horizontally and have dual-spring action so that the touch is heavier at the bottom of the key travel, but there is no other auditory or tactile feedback for key-switch closure. We felt that the keyboard touch was vague, and this prevented rapid typing during our limited use of the machine. Function keys surround the upper and right side of the numeric keypad. Control keys (such as Return, Tab, Enter, and Shift) that are either the same size or even larger at the base than the character keys have the same raised striking area as an alphanumeric key. Two important symbols for Unix users and programmers can be produced only by pressing Control and another key simultaneously. These symbols are | (for the pipe feature) and \, used primarily in C-language programming.

The system is housed in a large but attractive integrated enclosure containing a seven-slot system card cage, the floppy-disk drive, the console video display (a 12-inch-

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Editor's Note: *Since this article was written, Radio Shack has announced a new standard configuration for the Model 16B: a 256K-byte system with one 8-inch floppy-disk drive and a built-in 15-megabyte hard-disk drive for $6999.*

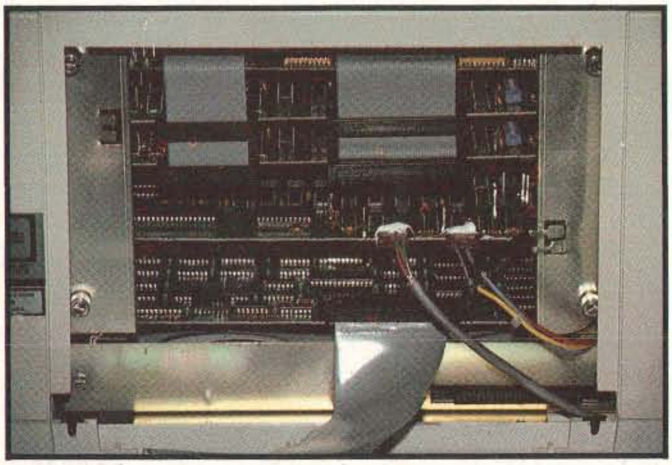

Photo 3: *The Model 16B's card cage.*

At a Glance

Name
TRS-80 Model 16B Computer

Manufacturer
Radio Shack Division
Tandy Corporation
1300 One Tandy Center
Fort Worth, TX 76102

Size
14 by 21¼ by 23½ inches

Weight
Approximately 50 pounds

Components

Processors:	Motorola 68000 running at 6 MHz, Z80A running at 4 MHz
Memory:	Z80A with 64K bytes; M68000 with 256K bytes minimum, 768K bytes maximum (128K-byte memory-expansion board is $699, 128K-byte add-on-chip kit is $299)
Display:	24 lines by 80 columns, green phosphor, brightness and contrast controls, upper- and lowercase characters, 32 symbol graphics characters
Keyboard:	Detached 86-key stepped keyboard with 6-foot coiled cord; keytops are textured to avoid glare
Data Storage:	One 8-inch double-sided double-density 1¼-megabyte floppy-disk drive installed in the console
Expansion:	Seven-slot card cage; three slots are free in a 512K-byte system with a 12-megabyte hard-disk drive

Operating Systems
TRSDOS-II/16 (single user), TRSDOS-12 (single user), TRS-Xenix (multiuser)

Documentation
TRS-80 Model 16B Operator's Manual, 100 pages; *TRSDOS-II Reference Manual*, 326 pages; *TRS-Xenix Operations Guide*, 161 pages; *TRS-80 Model 16B Owner's Manual* (actually the *TRSDOS-16 Operating System Manual*), 256 pages; *Twelve-megabyte Hard Disk Owner's Manual*, 50 pages; *BASIC Reference Manual* (TRSDOS with BASIC interpreter), 235 pages; *Assembler-16 Manual*, 353 pages

Software Available
TRS-Xenix multiuser software: General Ledger ($599); Payroll ($699); Accounts Receivable ($599); Accounts Payable ($599); Order Entry/Inventory Control System ($599); Sales Analysis ($399); Job Costing ($199); Multiplan spreadsheet ($349); COBOL Development System ($699); BASIC interpreter ($299); and TRS-Xenix Development System with C language, electronic mail, text processing, and Xenix utilities and Assembler-16 ($750). The Model 16B also uses Model II and Model 12 software in the Model II compatibility mode (single user)

Optional Features
Second internal 8-inch floppy-disk drive ($799); one ($1299) or two ($2098) external floppy-disk drives; 11.6-megabyte primary hard-disk drive ($3495); 12-megabyte secondary hard-disk drives (three maximum, $2495 each); graphics video adapter board (monochrome 640- by 240-pixel resolution, $499); DT-1 data terminals (two maximum, $699 each)

Prices
256K bytes, one floppy-disk drive: $4999
256K bytes, two floppy-disk drives: $5798
384K bytes, one floppy-disk drive, one 11.6-megabyte hard-disk drive: $9995
512K bytes, one floppy-disk drive, one 11.6-megabyte hard-disk drive (minimum recommended Xenix configuration): $10,294

diagonal green-phosphor tube without antireflection treatment), the Motorola 68000 processor board, a memory board, and the hard-disk interface. This configuration costs in the neighborhood of $16,000, complete with a top-of-the-line Radio Shack letter-quality printer and a complement of multiuser accounting and core business-applications programs. Moderate-resolution (640- by 240-pixel) monochrome-video-graphics hardware is an option for the console terminal but is not yet supported by Xenix software.

Software

The optional single-user software library includes all TRS-80 Model II and 12 programs (nearly 50 from Radio Shack), each targeted at a broad base of business and professional users. The optional multiuser software library is, at this writing, confined to program-development software (available at additional cost; see At a Glance), "big four" accounting packages (General Ledger, Accounts Payable, Accounts Receivable, Payroll), and Microsoft's Multiplan advanced spreadsheet. Other software includes an order-entry/inventory-control system, sales analysis, and small-contractor job-costing programs. COBOL and BASIC languages are sold separately, as is the TRS-Xenix development system, which includes many utilities, the C language, Unix-style communications, Unix-style text processing (*not* word processing in the usual sense), and Unix's basic electronic-mail facilities.

Hardware

The TRS-80 Model 16B has two serial RS-232C ports, a parallel printer port, and a space on the connector panel reserved for the Datapoint/Radio Shack Arcnet LAN interface. In its current configuration, then, the system can handle only three users: two working on dumb terminals, such as Radio Shack's model DT-1, and a third working on the system console. The system card cage has space for seven cards. The maximum RAM (random-access read/write memory) allowable currently is 768K bytes, which is obtained using the M68000 microprocessor's on-board memory and two 256K-byte cards. The 64K bytes of Z80 memory are on a separate card below the card cage (photo 3) in the base of the system unit. The M68000 memory cards are connected to the processor board by two card-edge ribbon cables in a bus configuration, in addition to their interface to the motherboard. One card slot is used for the hard-disk interface, and another is used for the console terminal electronics. Two slots are unused in the configuration we tested. Recent rumors suggest that Radio Shack is planning to announce a six-port terminal multiplexer board, along with a 15-megabyte hard-disk drive. The multiplexer and an Arcnet board would fill the card cage and, according to our system-performance evaluations, provide enough interfaces to cause severe response delays for a full load of users. It is possible that this machine could support only two to four users in a program-development environment, if our previous experience with similar hardware applies to this machine. In fact, with only 384K bytes of memory (one advertised "complete" configuration), Xenix may even be noticeably slow with three users. However, the three-user configuration with 512K or 784K bytes of memory is clearly supported and seems to make the most sense in terms of the speed of the operating system and the memory-segmentation scheme that is implemented.

Local-Area Networking

For larger groups of users, the Arcnet board might be used to interconnect clusters of three users per Model 16B (i.e., a distributed-star network). As a user, you would have access to the 16B to which your terminal is connected and would also have read and/or write access to programs and data for which you have authorization on other 16Bs connected to the network. Typically, in other Unix systems (although there is no official indication that Radio Shack will go this way), networking means you run a program at your terminal that lets you log onto the desired remote system via the physical network facilities. You may then do work on the remote system or transport programs and data back to the system to which your terminal is directly connected. You must have a user account on each networked Unix system that you want to use. Thus, you may have several accounts on several different machines in the office, and it is possible that none of the accounts would have all of the up-to-date information you desire to use in a particular work session. This network architecture itself promotes redundant storage of data on several systems. The software for this type of network access is standard Unix fare: `uucp` is the Unix-to-Unix copy program (used for file transport and intersystem mail), and `cu` is the call-Unix program (used to establish a logical user connection over a preexisting physical connection between systems). The `cu` program lets you log onto the desired system as though your terminal were directly connected to that system. The `cu` program also allows file transport back to your actual host system. Xenix appears to have the standard Unix networking described above. This is good, but things can get much better.

In contrast, consider two alternative network architectures. The first (and by far the nicest to work on) is the virtual system. In this system, you would typically have your own powerful personal computer (e.g., a 16B) interconnected with other users' 16Bs by a local-area network (e.g., Arcnet). A program called the Network Manager would run on each active system as an invisible background task. All requests for files (i.e., programs, data, or directories) that cannot be satisfied on your system are referred to the Network Manager. The Network Manager then queries all other active systems on the network for the desired item and transports the item to your computer for execution, if that item is a program. If the item is not a program, an access link is created via the network, if you have the correct authorization. You never see all of this activity: you either get access to the file or receive an error message describing why access was denied (file not found, file found on another file system to which access was not granted, etc.). This type of network reduces data redundancy and, more important, provides you with a transparent network-wide access interface. The Model 16B could be hooked up to this type of network if Radio Shack, Datapoint, or Microsoft creates the right network software.

In the second alternative, the 16B's Arcnet hardware could be used in a simple star network where a central network "server" consists (usually) of a central processor and disk system. Each user workstation would be a Model 16B computer having either no mass-storage system or only a floppy-disk drive. The central server is used for all fast bulk storage and may also be used to route data from one user's workstation or file system to that of another user. It is easy to make this sort of network operate like a virtual system, but such a network is usually slower and is vulnerable to faults in the server. Program execution on each of the workstations might also be slower due to the need to retrieve program or data segments from the central server's disk. The advantages of this type of local-area network are that it is low in cost, it can minimize data storage redundancy, it provides a single integrated and coordinated file system, and, finally, it has relatively good compute performance for processes that are entirely memory resident. Whatever Radio Shack decides to do with the LAN facilities it has in store for us, you can bet that it will be proprietary and will promote the sale of other Radio Shack computer products.

Xenix on the Model 16B

The Xenix implementation on the 16B is an enhancement of Unix version 7 with the addition of several extensions from the University of California, Berkeley, and from Unix System III. (For more information on the Unix operating system, see David Fiedler's three-part article, "The Unix Tutorial," appearing in the August, September, and October 1983 BYTEs. See also the several theme articles in the October 1983 issue on Unix.) The system comes in two pieces. The basic multiuser Xenix operating system and a pretty good collection of utilities comes with the purchase of a Model 16B. The Xenix Development System adds numerous utilities and C, the language in which Unix is written. C is being touted in the industry as the only way to write truly portable fast-executing code. Let it be known, however, that not all versions of C are created equal. Unfortunately, despite a clear definition of what C is and what it's supposed to do by Kernighan and Ritchie in *The C Programming Language* (reference 1), several nonstandard C compilers are available on the market today. Worse, some compilers have subtle differences in their implementations that hinder true portability—code that runs well in some environments gets sick in others. The TRS-Microsoft implementation appears to be reliable and standard. The Xenix Development System adds many useful utilities and commands including the Unix electronic-mail facilities and Unix communications. Xenix is, in comparison

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to other manufacturer's offerings, a fairly complete implementation of Unix (minus the languages that come standard with real Unix) at a moderate cost. However, it is possible that Unix System V will be released to end users at a low cost and so offer significant competition to Xenix.

Xenix and Unix System Calls

The most widely distributed and used version of Unix today is version 7. Microsoft Xenix is a derivative of this version with some enhancements and is available as a single or multiuser environment. Like Unix, Xenix requires a good deal of memory (at least 256K bytes for a one-user system) and a lot of hard-disk space (we think that a 10-megabyte disk with an average access time of 95 milliseconds is the minimum practical). Both systems work better with more memory and with faster, bigger disks. Xenix supports all of the version 7 standard system calls (what a program uses to talk with the operating system), plus some extensions that improve multiuser access to the system's resources. The standard system calls (similar to CP/M's BDOS, or basic disk operating system, calls) are shown with brief explanations in table 1. The most notable extensions to Unix are in the kernel; they affect file access and signaling between tasks (called processes in Unix). Unix and Xenix are structured much like an onion; at the center is the kernel, the basic code that makes it all go. Successive layers of code add utilities, features, languages, and the user interface—called the shell. The kernel has the task of making the link between the Unix standard environment and the nitty-gritty of the machine on which the operating system is running. Thus, standard system calls can be issued from programs, and their translation into action on a particular machine is handled by the kernel. This is the key to why Unix is a highly portable system. You only have to rewrite the kernel and a few device drivers to transport the whole system to another machine, using a standard C compiler and an assembler available on the target machine. One of the primary concerns in using Unix in a commercial multiuser environment is how to achieve orderly and centrally-controlled access to disk data at the individual record level. Standard Unix does not support the types of access-permission control and concurrency control (file and record locking) required by business programs. This is one of the first areas addressed by Xenix enhancements to standard Unix.

File Access Control

The Xenix extension routine `locking` locks or unlocks a specific number of bytes in a file. The process that issues the lock command has read/write access to these bytes and may allow read-only access to other processes. The parameters `mode` and `size` control these actions. If the region being locked is already locked by another process, the locking routine requesting access can wait for the entire region to be unlocked or can return with an error code. A Unix/Xenix standard specification for this routine is shown here:

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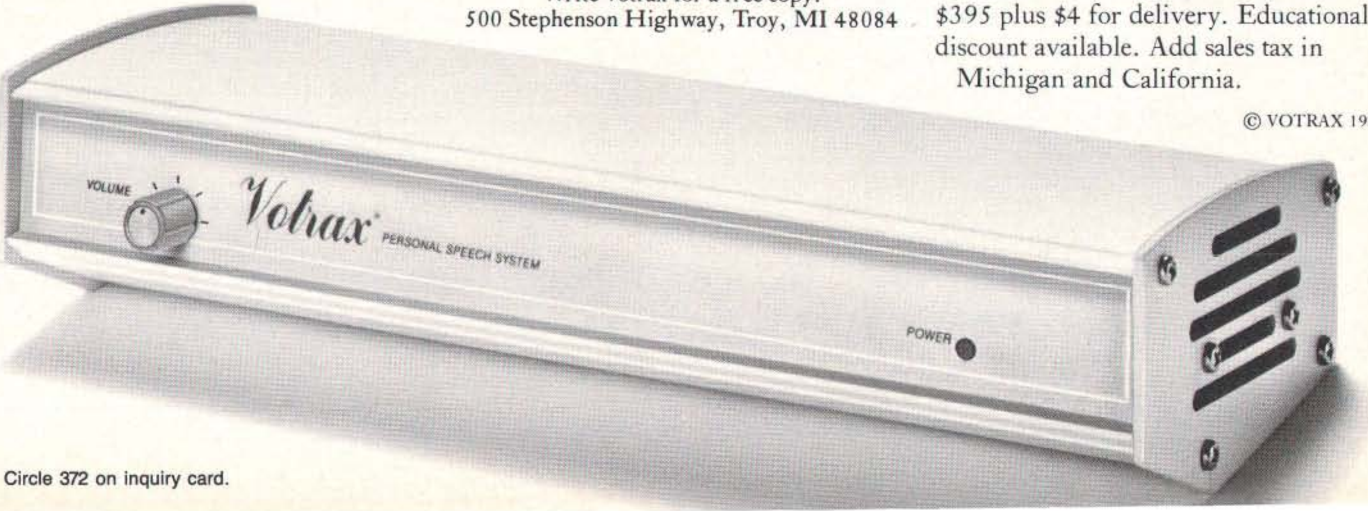

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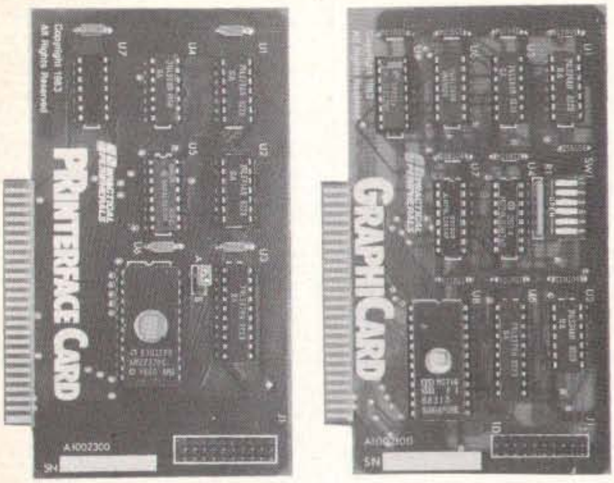

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```
locking (fildes, mode, size)
int     fildes;
int     mode;
long    size;
```

We'll describe some of the notation as we go along, but a complete specification of the C language is contained in Kernighan and Ritchie's book on C. All Unix and Xenix documentation uses headers such as this one to specify exactly what a routine's calling sequence is.

access	determine accessibility of file
acct	turn accounting on or off
alarm	schedule signal after specified time
brk	change core allocation
chdir	change working directory
chmod	change mode of file
chown	change owner and group of a file
chrrot	change the root directory
close	close a file
creat	create a new file
dup	duplicate an open file descriptor
execl	execute a file
exit	terminate process
fork	create a new process
getgid	get group identity
getpid	get process identity
getuid	get user identity
indir	indirect system call
ioctl	control device
kill	send signal to a process
link	link to a file
lock	lock a process in primary memory
lseek	move read/write pointer
mknod	make a directory or a special file
mount	mount a file system
nice	set program priority
open	open file for reading and writing
pause	stop until signal
pipe	create an interprocess channel
profil	execution time profile
ptrace	process trace
read	read from file
setuid	set user identity
setgid	set group identity
signal	catch or ignore signals
stat	get file status
stime	set time
sync	update super block
time	get date and time
times	get process times
umask	set file creation mode mask
umount	remove a file system
unlink	remove directory entry
utime	set file times
wait	wait for process to terminate
write	write on a file

Table 1: *Standard Xenix system calls.*

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Note that the notation is terse and assumes that you understand both the nuances of the C language and how C was used to implement the function.

The parameter fildes is the file description (i.e., the unique identifier) of the file to be locked. Variables are shown in C-language-type declaration statements as either integer (int) or long integer (long).

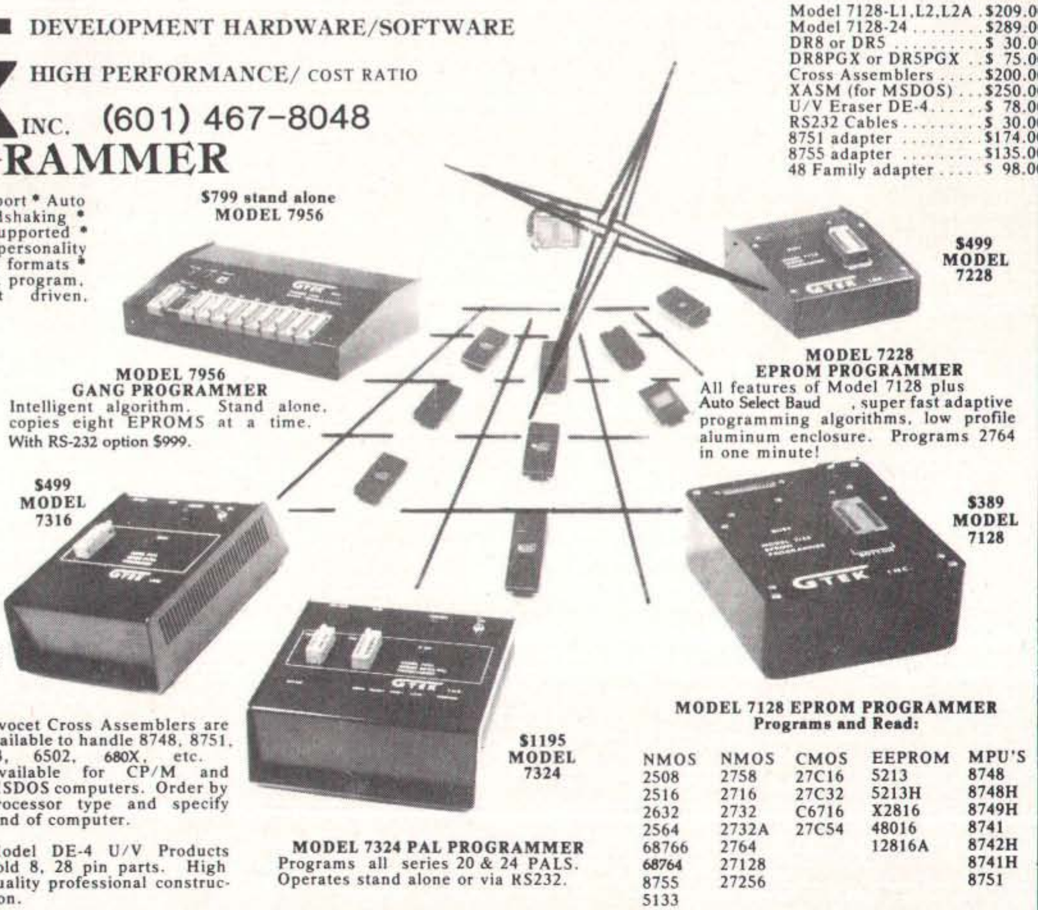
Binary semaphores are implemented in Xenix as a special file type having a length of 0. Each semaphore has a name (sem_name) and a mode that specifies permissions. A program creates the semaphore as follows:

```
int      creatsem (sem_name, mode)
char     *sem_name;                  /* a character pointer */
int      mode;
```

Execution of the integer function creatsem causes the semaphore to be reset and a unique semaphore identification number to be returned. Other processes can then open the semaphore with a routine open_sem, but access is granted only if the calling process has been given permission by the creating process. The routine wait_sem suspends the calling process until that process is signalled by the routine sigsem. More than one process may wait for a given semaphore to be set. A first-in-first-out (FIFO) queue is maintained by the system for each semaphore. A program that reads a shared file issues sigsem when it is done with the file. The sigsem call awakens the next process on the FIFO stack that is waiting to use the file. The routine nbwaitsem checks to see if the queue for a particular semaphore number is empty.

Thus, the semaphore routines provide the tools with which programmers can construct a binary signaling system between processes. The system is totally maintained by the programmer. A high degree of skill is required to use these facilities. But some such facilities are essential to the implementation of any multiuser application program on a system where one action must be completed before the initiation of the next.

Xenix also provides several convenience routines such as a "check" routine, rdchk, which looks to see whether there is any data to be read on an input stream. Programmers can use the routine to avoid annoying "hangs" on inactive input streams. The routine shutdn does all of the housekeeping necessary to shut down the Xenix system in an orderly fashion, including flushing all buffers to disk and halting the central processing unit. The consequences of a disorderly shutdown, caused by a power outage or an inadvertent flick of the power switch on the disk or the processor, are quite uncomfortable. Data and even whole files and file systems can be lost without the possibility of resurrection (unless you really know what you are doing). To reduce the impact of such improprieties, Xenix also supplies a tool that allows some of the worst effects of a damaged file system to be fixed. File-system-repair programs can replace the root file system's "super block" by passing a new super block in sblk,



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a structure that contains all of the header declarations for the super block of the file system to be repaired.

The Unix File System

The Unix file system is a hierarchical, or tree, structure. Microsoft has implemented the same general structure in a recent rewrite of its operating system for the IBM Personal Computer, PC-DOS version 2.0. The root directory, `/`, is where everything starts. Within `/` are kept data files, files that contain programs, and files that are directories of other files. It also contains a directory called `usr`, which contains all of the user directories. Let's suppose that a user named Randy has, as his home directory, the file called `randy`. Randy writes a program called `hello`. To run that program it is only necessary to type the name of the program. What you type can be the whole name (`/usr/randy/hello`) or an abbreviation, depending on where you are—that is, what your current directory is. If you type `cd /usr/randy`, your current directory is `randy` and you can just type `hello` to execute the program. If your current directory is `/usr`, you must type `randy/hello`.

Files and file systems are held together with a glue made of pointers. Files reside in any blank space available on a disk. If the first space available is too small, the file is written partly in that space and partly in the next free space. Pointers keep track of what is where. Because directories are nothing but files, it is possible that a single bad pointer can lose hundreds or thousands of other files.

Additional problems can occur in relation to another feature of the operating system: to enhance performance, writes to disk are not necessarily done when requested by the user or calling program. This is because Unix I/O is heavily buffered in memory. When some event calls for a write, the write occurs to the buffer and the system decides whether it is time to flush the buffer to the disk. Every 30 seconds or so a housekeeping process (called a daemon) comes along and flushes the buffers so that the disk doesn't get too far out of synchronization. Not surprisingly, this daemon is called `sync`. Sometimes, due to a power fault, a bad memory location, or some other event, the disk and the memory buffers are left unsynchronized as the system crashes. Even the best-run and best-maintained Unix system will encounter an occasional crash or partial crash. The result is usually a somewhat damaged file system. It is up to the person responsible for system maintenance to repair the damage.

System Maintenance

Unix version 7 supports programs used for file-system maintenance, backup, and system accounting. Xenix has made a number of extensions to the system to make maintenance easier. File systems can be repaired using `dcheck`, `icheck`, `ncheck`, and `clri`. These utilities give the system maintainer a high degree of flexibility, but to be used effectively they also require a high degree of knowledge about the file system. Xenix includes a Unix System III utility `fsck` (file system check) to help simplify repairs to the file system.

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Program	Unix Version 7	Xenix	TRSDOS
log in accounting	ac	ac*	
turn on system accounting		accton*	
prompt for correct time		asktime*	
clear i-node	clri	clri*	
directory consistency	dcheck	dcheck*	
turn off terminals		disable	
incremental system dump	dump	dump	
directory of dump tape		dumpdir	
turn on terminals		enable	
file system consistency		fsck	
quickly halt system		haltsys	
storage consistency	icheck	icheck*	
test RAM			memtest
make a file system	mkfs	mkfs	format
make a special file	mknod	mknod	
add login ID to system		mkuser	
mount file system	mount	mount	
name for i-numbers	ncheck	ncheck*	
incremental system restore	restor	restor	
remove user from system		rmuser	
system accounting	sa	sa*	
print and set dump dates		sddate*	
gracefully halt system		shutdown	
become super user	su	su	
update super block	sync	sync	
back up script		sysadminn	backup
tape archiver	tar, tp	tar	
dismount file system	umount	umount	

*Available with the optional Radio Shack Development System.

Table 2: *Unix version 7 maintenance programs.*

Backup is a key to the integrity of Unix systems. Invariably, even with expert use of the file-maintenance utilities, files are lost due either to user error or to system error (user error is far more likely). The only effective remedy is a current backup of the file that was lost. Xenix supplies a menu-driven procedure (actually a shell script) called sysadmin to help users maintain an adequate backup of the system, and sddate is used to maintain a backup history for the system.

Normal system maintenance includes authorizing new users, deleting unneeded user accounts, establishing a logical connection between new hardware (e.g., terminals) and the system, and starting and stopping the system. Xenix has made many of these chores easier. The programs mkuser and rmuser establish (make) a user account and remove one in a far easier way than Unix, where the manager must edit the /etc/passwd file. In Unix version 7 the terminals were enabled and disabled by editing the /etc/ttys file. In Xenix the programs enable and disable simplify this process. The program shutdown is used to warn other users that the manager intends to shut the system down. The haltsys program accomplishes the shutdown quickly.

Table 2 is a brief description of the maintenance programs available in Unix version 7, Xenix, and, for com-

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parison, TRSDOS (an operating system that we perceive to be similar in scope—if not in structure or detail—to most of the common single-user operating systems in the microcomputer market today). Entries in tables 2 through 15 marked with an asterisk (*) in the Xenix column are available with the optional Development System from Radio Shack or Microsoft. Entries in tables 3 through 15 marked with the † symbol are from the Berkeley implementation of Unix.

Program Development

Unix version 7 supports the program-development environment with a standard set of languages (included in the operating system package): f77 (FORTRAN 77), RATFOR (Rational FORTRAN preprocessor), a rudimentary BASIC interpreter, and, of course, C, as well as a host of useful utilities such as an assembler, a debugger, and library management. Table 3a shows the program support utilities available in several operating systems. Table 3b lists the programming languages, utilities, and related programs available in Unix and Xenix. Note that language software for Xenix is available only in the Development System or as a separate package. The arcv utility converts an archive from PDP-11 format (most of Unix was originally developed on PDP-11s) to one suitable for the Motorola M68000. Another utility, ctags, is used with vi, a full-screen (visual) editor of considerable power and complicated syntax, to edit programs using more than one source file. With ranlib you can convert an archive to a randomized library that can be used with the link editor—a program that takes the output of compilers or assemblers (i.e., object programs) and puts them together to form a single runnable program (thus, a "fix" in one program module requires only short recompilation and linkage editing to have the program running again). The Berkeley extensions mkstr, strings, and xstr minimize the storage space required for strings used in C programs.

Unix/Xenix Text Processing

The Unix community has spawned a number of editors and text processing systems. Xenix makes many of the text processors and two editors available to users. The Unix line-oriented editor ed is easier to use on a printing terminal than on a screen, but it is simple and quick and, for short texts, very effective. The vi editor has a manual nearly an inch thick and is a very powerful screen-oriented character editor. Each of these editors can be used to prepare text that can be subsequently processed by one of the formatting programs. Note that what you see is *not* what you get in the system. The text-processing formatters such as nroff, troff, and neqn provide tremendous flexibility and handle chores such as typesetting, mathematical equations, tables, and reference sections. The problem is that this is a multistep process. You place formatting commands into the text during text editing. To see the effect of these commands, you submit them to the proper formatter and print the result. You then proof the output, noting typographical errors, editorial changes, and format goofs. Back to the

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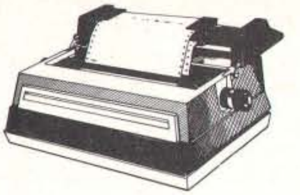

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(3a)

Program	Unix Version 7	Xenix	TRSDOS	CP/M
debugger	adb	adb*	debug	ddt, save
archive/library manager	ar	ar*		
convert archive format		arcv*		
assembler	as	as*		asm
create a tags file		ctags*†		
link editor	ld	ld*		load
ordering for library	lorder	lorder*		
maintain program group	make	make*		
message file from C		mkstr*†		
print name list	nm	nm*		
octal dump	od	od*	list	dump
display profile data	prof	prof*		
size of an object file	size	size*		stat
remove object file parts	strip	strip*		
time a command	time	time*		
randomize library		ranlib*		
extract objects strings		strings*†		
extract C strings		xstr*†		

*Available with the optional Radio Shack Development System.
†From the Berkeley implementation of Unix.

(3b)

Program	Unix Version 7	Xenix
BASIC interpreter	bas	
unlimited precision	bc	bc*
C program beautifier	cb	cb*
C compiler	cc	cc*
desk calculator	dc	dc*
FORTRAN 77 compiler	f77	
lexical analyzer generator	lex	lex*
C program verifier	lint	lint*
macro processor	m4	m4*
rational FORTRAN dialect	ratfor	ratfor*
structure FORTRAN	struct	struct*
parser generator	yacc	yacc*

*Available with the optional Radio Shack Development System.

Table 3: *Support utilities of four operating systems (3a) and languages and utilities available for Unix and Xenix (3b).*

editor. The typos and changes are easy, but figuring out how to get the formatting just right is a matter of considerable effort for those of us who haven't had the foresight to get a Ph.D. in nroff. Tabel 4 shows what text utilities are available in Unix and Xenix.

File Processing

File processing was an area of considerable concern to the Unix system designers. An efficient program-development environment requires all sorts of neat ways to get at things, to see if one thing is the same as another, or to sort things into some reasonable order. Xenix provides the complete Unix version 7 file-processing set and extends the set by a considerable margin. Table 5 shows the file-processing capabilities of Unix, Xenix, TRSDOS,

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and CP/M. The copy utility is a handy extension that copies groups of files, whereas cp does so only with some fairly arcane manipulation. A Berkeley enhancement called more displays files a screenful at a time. Members of the grep family, including look, are used to

Program	Unix Version 7	Xenix
simple text formatter	roff	
text typesetting	troff	troff*
text formatter	nroff	nroff*
typeset mathematics	eqn	eqn*
format mathematics	neqn	neqn*
format nroff/troff	tbl	tbl*
format references	refer	refer*
insert references		lookbib*
simulate typesetter	tc	tc*
greek letters print	greek	
reverse line feeds	col	col*
remove format constructs	deroff	deroff*
check eqn usage	checkeq	checkeq*
prepare for statistics		prep*
format output		sp*

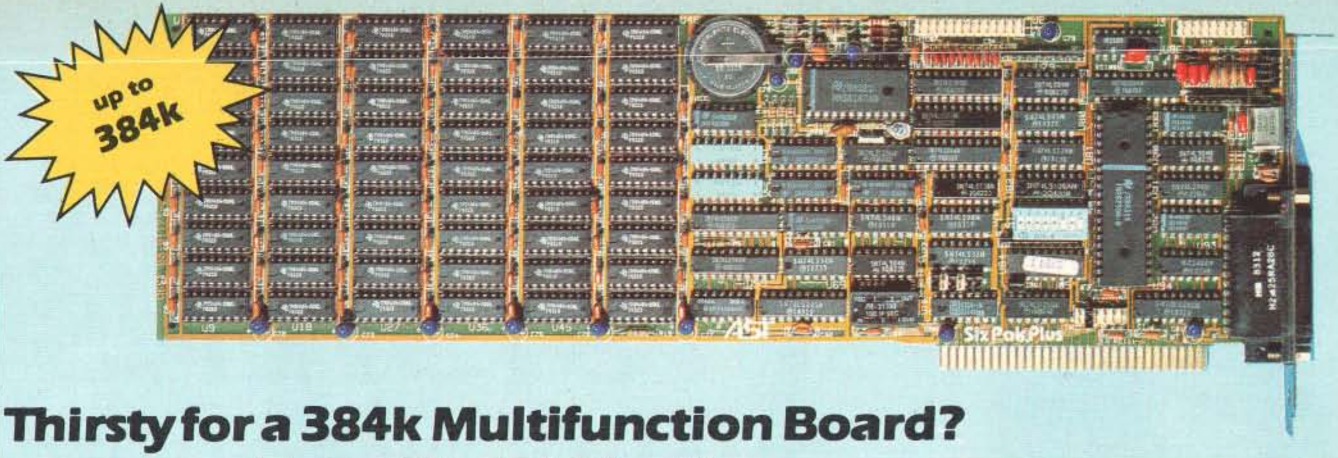
*Available with the optional Radio Shack Development System.

Table 4: *Unix and Xenix text utilities.*

Program	Unix Version 7	Xenix	TRSDOS	CP/M
pattern processing	awk	awk		
append file to file	cat	cat	append	
catenate and print	cat	cat		type
compare two files	cmp	cmp*		
choose common lines	comm	comm*		
copy groups of files		copy	move	
copy	cp	cp	copy	pip
convert and copy a file	dd	dd		
differences in two files	diff	diff		
differences in three files		diff3*		
full expression search		egrep*		
string search		fgrep		
limited expression search	grep	grep		
print beginning of file		head*†		
relational database join	join	join*		
find lines in sorted list	look	look*		
browse file		more†		
print page headings	pr	pr		
reverse lines		rev*		
stream editor	sed	sed		
sort or merge files	sort	sort		
split file	split	split*		
checksum of file	sum	sum*		
print end of file	tail	tail		
translate characters	tr	tr*		
topological sort	tsort	tsort*		
duplicate lines	uniq	uniq*		
word count	wc	wc*		

*Available with the optional Radio Shack Development System.
†From the Berkeley implementation of Unix.

Table 5: *File-processing capabilities of four operating systems.*



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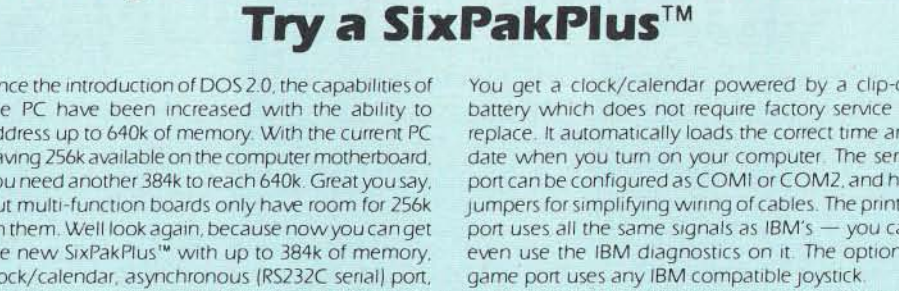

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Program	Unix Version 7	Xenix	TRSDOS	CP/M
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execute on log-in	.profile	.profile	auto	
create shell script	ed	ed	build	ed
schedule programs	cron	cron		
shell with C-like syntax		csh†		
echo arguments	echo	echo		
evaluate expression	expr	expr		
return false		false		
fix last command line			fc	
get string from input		gets*		
signal process	kill	kill		
run command with priority	nice	nice*		
run immune to hangups	nohup	nohup*		
return a random number		random*		
read line from terminal	read	read		
execute a shell script	sh	sh	do	submit
suspend for interval	sleep	sleep		
return true		true		
duplicate output	tee	tee*	dual	
condition command	test	test		
shell with TRSDOS syntax		tsh		
wait for completion	wait	wait		
output unit end of pipe		yes		

*Available with the optional Radio Shack Development System.
†From the Berkeley implementation of Unix.

Table 6: *Program-control interface facilities available on four operating systems.*

search files for patterns or words, and cmp, diff, and diff3 are file-content comparison programs.

Xenix Shells

The program control interface for Unix systems is implemented by a shell program. This shell is the outermost skin of the operating system onion. Xenix has three shells available. You are assigned a shell when your user account is created on the system. Changing shells is a simple matter. It is possible, but not easy, to write a whole new shell and use it instead of one of the shells provided. An easier matter is to write "shell scripts" within either the standard Bourne shell or the Berkeley C-shell. Shell scripts can help make user environments that are much easier for unsophisticated users than the standard environments. Menu interfaces, for example, can be implemented without excessive difficulty. Radio Shack has also provided tsh, which implements an emulation of the TRSDOS environment and its commands (such as dir) for users familiar with that interface and unwilling to tackle the standard Unix fare. Table 6 is a comparison of the program-control interface facilities available on Unix, Xenix, TRSDOS, and CP/M.

Communication

Unix has supported intersystems communication for some time and as a standard part of the system. Xenix has expanded the complement of communications programs available. Of particular note is uux, a program that lets you specify separate systems for program input, execution, and output. Naturally, these systems must be linked by auto-dial modems or by a local-area network. Table 7 is a comparison of utilities available within Unix version 7, Xenix, and TRSDOS.

Program	Unix Version 7	Xenix	TRSDOS
reminder service	calendar	calendar*	
call up Xenix (terminal emulation)	cu	cu*	terminal
send or receive mail	mail	mail*	
permit or deny messages	mesg	mesg*	
write to user	write	write*	
Unix-to-Unix copy (file transfer)	uucp	uucp*	host
uucp log summary		uulog*	
Unix-to-Unix execution		uux*	
write to all users	wall	wall	

*Available with the optional Radio Shack Development System.

Table 7: *Communication utilities. Note that Unix supports both communications among users on one system and communications among separate systems.*

File-Access Control

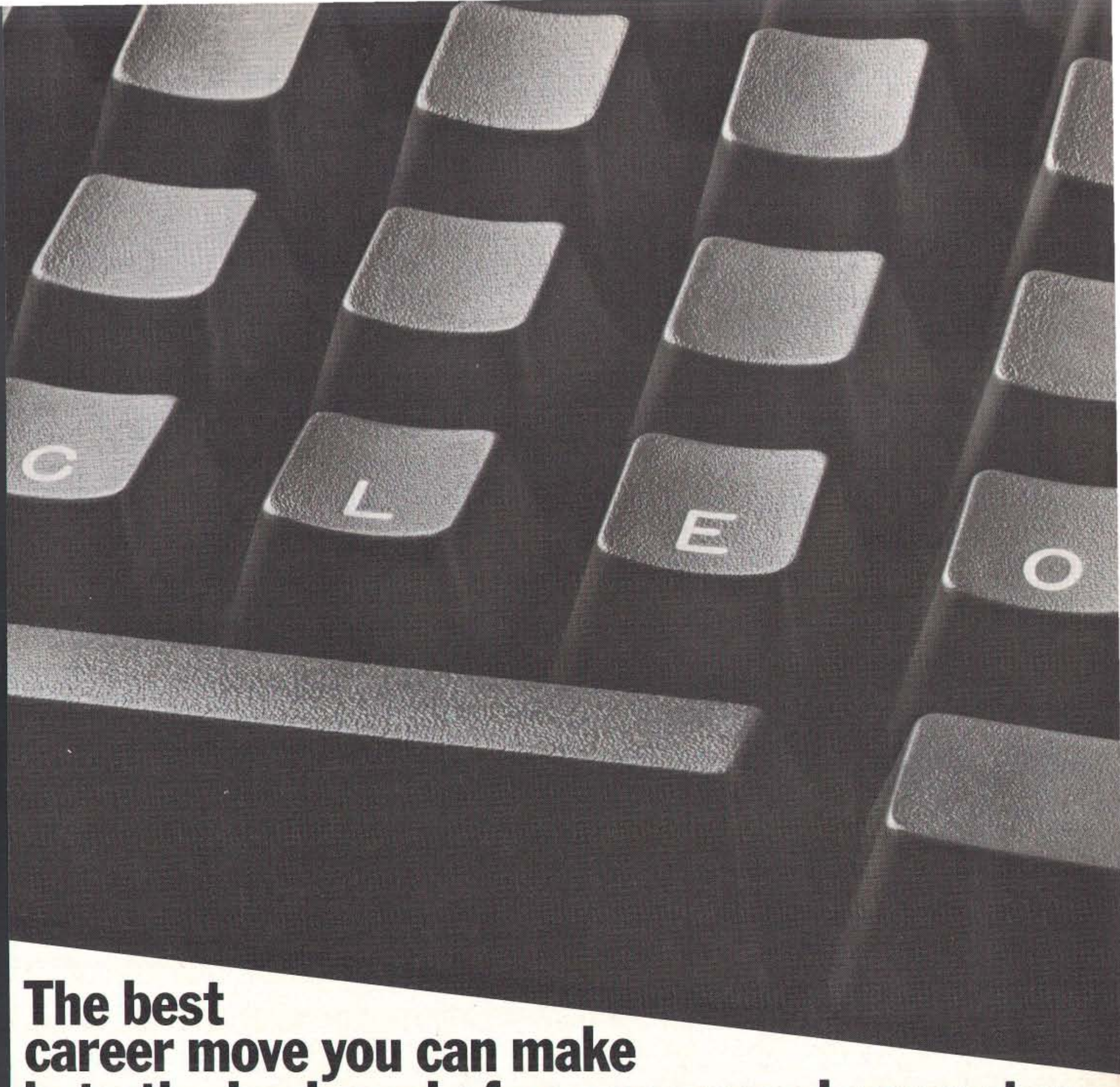
Unix files have sophisticated access controls. Each named file has an owner who, in turn, belongs to a group. The file has a set of access permissions and is marked with the date created and the date last modified.

Changing shells is a simple matter: it is possible to write a whole new shell and use it instead of one of the shells provided.

The utilities mv (move a file—the same as renaming it), chown (change owner), chmod (change mode—the same as changing access attributes), chgrp (change file group), settime, and touch are all used to change these access attributes. A directory is a special file that has special attributes and that contains references to other files. Thus, several of the listings in table 8 are directory-control functions. The utility ln (link) allows a file to appear in more than one directory under different names. Table 8 presents a comparison of Unix, Xenix, TRSDOS, and CP/M on file-access control.

Terminal Handling

Unix provides an easy method for handling nearly any terminal in a way that is (usually) transparent to users and their application programs. Settings include speed (data rate), parity, echo (i.e., full or half duplex), the characters to use for backspace and kill, and the end-of-file characters. The Berkeley enhancement tset uses the terminal-capabilities database /etc/termcap to set terminal modes. Note that in Xenix, it is impossible to set terminal



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Program	Unix Version 7	Xenix	TRSDOS	CP/M
change working directory	cd	cd		
change file group	chgrp	chgrp		
change file owner	chown	chown		
change file mode	chmod	chmod	atrib	stat
find files	find	find*		
make a link	ln	ln		
make a directory	mkdir	mkdir		
move files, directories	mv	mv	rename	ren
remove files	rm	rm	kill,purge	era
remove directories	rmdir	rmdir		
change file dates		settime*		
change modified date		touch*		

*Available with the optional Radio Shack Development System.

Table 8: *File-access control functions of four operating systems.*

Program	Unix Version 7	Xenix	TRSDOS
set key click			click
clear screen			cls
set terminal options	stty	stty	setcom
set terminal tabs	tabs	tabs*	
set terminal modes		tset†	

*Available with the optional Radio Shack Development System.
†From the Berkeley implementation of Unix.

Table 9: *Terminal commands.*

Program	Unix Version 7	Xenix	TRSDOS	CP/M
line editor	ed	ed		ed
encode/decode	crypt	crypt*		
permuted index	ptx	ptx*		
find spelling errors	spell	spell*		
non-English spelling	typo			
screen editor		vi*†		

*Available with the optional Radio Shack Development System.
†From the Berkeley implementation of Unix.

Table 10: *Text-manipulation facilities of four operating systems.*

Program	Unix Version 7	Xenix	CP/M
sign on	login	login	
log in to a new group	newgrp	newgrp	
change log-in password	passwd	passwd	user

Table 11: *Access-protection facilities.*

tab stops unless you purchase the optional Development System. See table 9 for terminal commands.

Much program development time is spent in an editor. A good editor makes program development much easier and much less error-prone. Note, however, that an editor is not a word processor. The vi editor is a very powerful screen-oriented editor that comes from the Berkeley Computer Science Labs. It relies on the termcap file to tell it how to make magic things happen, even with comparatively dumb terminals. This editor takes considerable effort to learn, but once you know it well, it allows very fast text manipulation. Table 10 compares editing/text-manipulation facilities on four operating systems.

System Access

Unix was conceived as a timesharing system. Accordingly, the access-protection facilities on Unix and Xenix are far better developed than on either of the single-user operating systems shown in table 11. Users have a password that may be changed by use of the passwd command. Files are protected by user (the file owner) and by group. A user may belong to more than one group. As a safety measure, on some systems repeated unsuccessful attempts to log into a Unix system may trigger a software disable of the terminal port being accessed.

Unix has for some time had standard support for limited line and curve drawing on a number of different graphic devices. Although not very comprehensive and not nearly as user-friendly as some current commercial packages, simple graphics can be done on a basic Unix/Xenix system. Table 12 shows the three routines generally available (in the Development System for Xenix).

Unix/Xenix has a general-purpose printer spooler that works on whatever has been set up as the system's printer. In contrast, TRSDOS has several explicit and useful individual commands. These are shown in table 13.

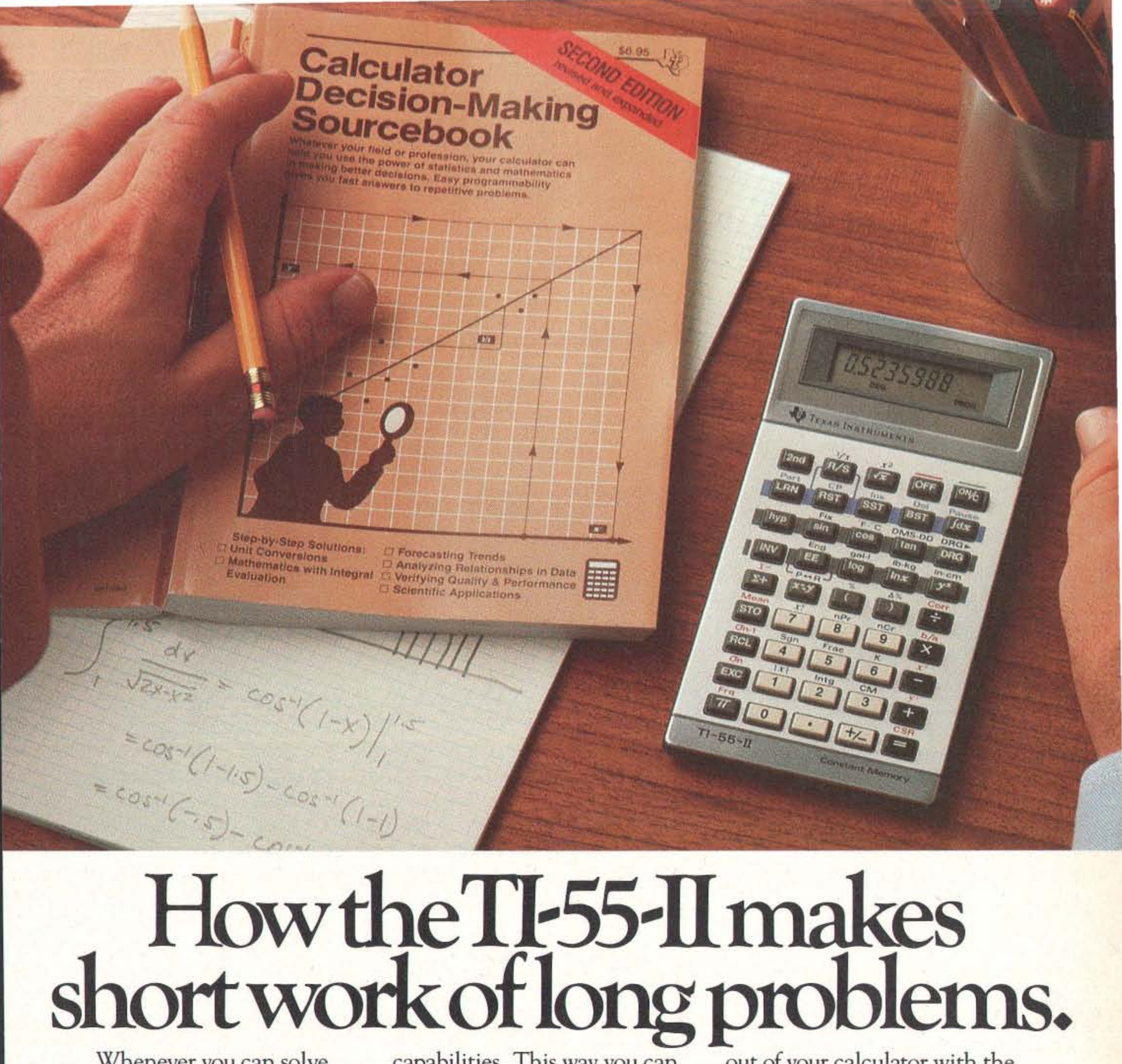
Program	Unix Version 7	Xenix
draw a graph	graph	graph*
interpolate smooth curve	spline	spline*
graphics filters	plot	plot*

*Available with the optional Radio Shack Development System.

Table 12: *Unix and Xenix graphics routines.*

Program	Unix Version 7	Xenix	TRSDOS
line-printer spooler	lpr	lpr	print
print current screen			screen
controls spooler			spool
set to top of form			t

Table 13: *Printer-handling commands.*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print calendar	cal	cal*	
CAI	learn	learn*	
system manual	man	man*	help
conversion program	units	units*	

*Available with the optional Radio Shack Development System.

Table 14: *Miscellaneous software features of Unix version 7, Xenix, and TRSDOS.*

Program	Unix Version 7	Xenix	TRSDOS	CP/M
current date and time	date	date	date, time	
disk free space	df	df	free	stat
disk usage summary	du	du		
determine file type	file	file*		
information on user		finger*†		
input/output statistics	iostat			
directory contents		l	dir	dir, stat
directory by column		lc†	files	
directory contents	ls	ls		
file system ownership	quot	quot		
print out environment		printenv*†		
process status	ps	ps		
system statistics		pstat*	status	
working directory name	pwd	pwd		
terminal name	tty	tty		
logged-in users	who	who		

*Available with the optional Radio Shack Development System.
†From the Berkeley implementation of Unix.

Table 15: *Status utilities of four operating systems.*

		Real	User	System
compile sieve	cc –O sieve.c –o sieve	33.0	5.4	5.9
execute sieve	sieve	10.0	9.0	0.2
simultaneous sieves	sieve&sieve&sieve&time sieve	38.0	9.0	0.2
compile terminal	cc –O terminal.c –o terminal	34.0	6.8	6.5
one terminal	terminal 1	16.0	0.4	7.5
two terminals	terminal 2	31.0	1.2	13.5
three terminals	terminal 3	46.0	1.9	19.7
compile disk	cc –O disk.c –o disk	36.0	6.4	6.4
one file	disk 1	5.0	2.0	0.5
two files	disk 2	8.0	3.7	1.2
four files	disk 4	13.0	7.5	2.1
eight files	disk 8	32.0	15.4	4.0
simultaneous sorts	sort f1>f1s&sort f2>f2s&sort f3>f3s&time sort f4>f4s	63.0	6.7	2.8
multifile sort	sort f1 f2 f3 f4 > sorted.file	97.0	37.9	12.8

Table 16: *Model 16B benchmark results. Entries in the Real column represent total elapsed time; entries in the User column represent time in the user process; and entries in the System column represent kernel time. Times are given in seconds.*

Miscellaneous Features

Because Unix is a fairly mature system, a lot of software has been written for it that is generally useful but hard to classify. Among the nice things available are those shown in table 14. The on-line system manual is handy for those who need access to specific manual pages fairly quickly. Note, however, that you need to know the name of the function you want to read about—you can't say, "Tell me about the utility that changes ownership of a file." The on-line computer-aided instruction (CAI) on Unix is nice, but using it tends to be a bit tedious. The conversion program for units is useful for those of us who have trouble converting from one measurement system to another in our heads.

Informal comparisons on other systems have shown the Model 16B to be about what you'd expect of a 6-MHz M68000-based machine running Unix and using the C language.

Unix and Xenix provide a number of valuable utility programs that inform you about system status and certain other data. Table 15 compares the facilities in Unix version 7, Xenix, TRSDOS, and CP/M in these areas. The finger utility from Berkeley retrieves information from your password file in a more readable format than contained in the file itself. You can list the status of processes running on the system with ps. This utility is useful in general but is especially useful to the system manager. Used in combination with the kill command, the ps utility allows the manager to free hung terminals or terminate runaway processes and unwanted processes. (Some microcomputer manufacturers don't make this feature available to their customers, claiming that their system software security scheme could be broken if it were available. However, this feature is an essential part of any Unix-style system and we applaud Microsoft and Radio Shack for making it available.) A System III utility called pstat prints out the kernel tables, which are loaded with useful information, if you know what you are doing.

TRS-80 Model 16B Performance

We subjected the Radio Shack TRS-80 Model 16B to an extensive list of performance tests. One of these tests was a compute-bound microprocessor speed test (the Sieve of Eratosthenes, used by Jim and Gary Gilbreath in "Eratosthenes Revisited: Once More through the Sieve," January 1983 BYTE, page 283), and others were designed by us for this article. We have done some informal comparisons on other systems available to us and have found the Model 16B to be about what you would expect of a 6-MHz M68000-based machine running Unix and using the C language. The Model 16B we tested had

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512K bytes of memory and the 12-megabyte hard disk. Terminal I/O was, according to Radio Shack literature, done by the second processor in the system, a 4-MHz Zilog Z80. The kernel seems to be particularly slow, especially as it attends to terminal I/O. In contrast, the kernel is rather efficient on disk I/O, but the overall system is hampered by slow hardware. Note, however, that long average disk-access times are a consequence of efforts to keep the system price down—you have to pay for the speed you get. Performance times were collected by executing the test using the Unix `time` command. This command monitors the time it takes to execute a process. Tabel 16 shows the results of the benchmarks in seconds. Total elapsed time ("Real"), time in the user process ("User"), and kernel time ("System") are reported individually. The Sieve program is shown in listing 1. The disk and terminal programs are shown in listings 2 and 3, respectively. The disk program is designed to provide a disk-intensive I/O load while the terminal program is designed to provide a serial-port I/O

Text continued on page 318

Listing 1: *The Sieve of Eratosthenes program used as a compute-bound microprocessor speed test on the Model 16B.*

```
#define TRUE     1
#define FALSE    0
#define SIZE     8190

char flags [SIZE + 1];

main ()
{
        int     count;
        int     i;
        int     iter;
        int     k;
        int     prime;

        printf ("10 iterations\n");
        for (iter = 1; iter <= 10; iter++)
        {
                count = 0;
                for (i = 0; i <= SIZE; i++)
                        flags [i] = TRUE;
                for (i = 0; i <= SIZE; i++)
                        if (flags [i])
                        {
                                prime = i + i + 3;
                                for (k = i + prime; k <= SIZE; k += prime)
                                        flags [k] = FALSE;
                                count++;
                        }
        }
        printf ("%d primes.\n", count);
}
```

Listing 2: *The disk benchmark program.*

```
#include <stdio.h>

FILE    *fp [8];
char    *file [] =
{
        "f1",
        "f2",
        "f3",
        "f4",
        "f5",
```

Listing 2 continued on page 316

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Listing 2 continued:

```
        "f6",
        "f7",
        "f8"
};

main (argc, argv)
int     argc;
char    *argv [];
{
        int     num;
        int     x;
        int     y;

        num = *argv [1] - '0';
        for (x = 0; x < num; x++)
                fp [x] = fopen (file [x], "w");
        for (y = 500; y > 0; y--)
                for (x = 0; x < num; x++)
                        fprintf (fp [x], "%50d\n", y);
        for (x = 0; x < num; x++)
                fclose (fp [x]);
```

Listing 3: *The terminal benchmark program.*

```
#include <stdio.h>

FILE    *fp [8];
char    *dev [] =
{
        "/dev/console",
        "/dev/tty01",
        "/dev/tty02",
        "/dev/tty03",
        "/dev/tty04",
        "/dev/tty05",
        "/dev/tty06",
        "/dev/tty07"
};

main (argc, argv)
int     argc;
char    *argv [];
{
        int     num;
        int     x;
        int     y;

        num = *argv [1] - '0';
        for (x = 0; x < num; x++)
                fp [x] = fopen (dev [x], "w");
        for (y = 0; y < 500; y++)
                for (x = 0; x < num; x++)
                        fputs ("how fast are your terminals\n", fp [x]);
        for (x = 0; x < num; x++)
                fclose (fp [x]);
}
```

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30 END	30 END
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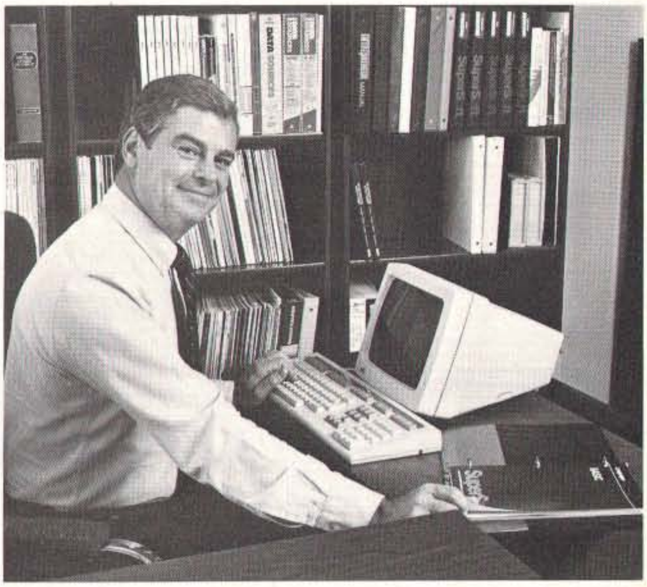

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Text continued from page 314:

load. We noted the compile times for each program and for various conditions of execution of each program. These times and conditions are shown in table 16. The Sieve was executed alone and as four background tasks, the last of which was executed under `time`. The terminal program used the console and either one or both of the terminal ports, each set to 9600 bps (bits per second), full duplex. The disk program wrote data to one, two, four, or eight files simultaneously. The Unix `sort` facility was then used to sort the resultant files under two conditions: a simultaneous sort of each file to its own destination file, and a multifile sort of each file to a single destination file. We believe these benchmarks to be a fair and accurate picture of the various activities that combine to form "system performance."

Analysis

The Radio Shack TRS-80 Model 16B is a fairly well-implemented and apparently well-supported Xenix system. Business-oriented software is available from the manufacturer, and it should be possible to get third-party "Unix-compatible" software for the machine in the near future. The machine we tested was not as reliable as we would have hoped. On several occasions, the display screen seemed to roll like a TV with a maladjusted vertical-hold control. We let the display roll for 5 to 10 minutes and the problem corrected itself on every occasion. More seriously, for unknown reasons, the 12-megabyte hard disk went down for an afternoon. After a couple of attempts to reformat the disk (23 minutes per attempt), we finally succeeded and were able to reload the operating system and development software. Everything went fine after that. This incident illustrates the three cardinal rules to be followed by all users of nonremovable hard disks: 1) back up your data and software, 2) back them up again, and 3) back them up a third time and put the media in another room.

When we opened the back of the system unit to look at the card cage, we found that one of the rivets used to attach a card-edge guide to the card cage wall had come loose, leaving the card in that slot partly unsupported. Such mechanical strain could result in premature board failure.

Despite these problems (we regard them as new-product teething pains), we thought the system was a useful and well-executed product. Radio Shack has come a long, long way from the TRS-80 Models I and III. With Radio Shack's customary attention to providing software and a wide variety of compatible peripherals, this system could become one of the more interesting offerings in its price class. It has already met and exceeded some of its competition in the area of available business software. Its only failing in addressing its target market is its use of the standard Unix shells. A turnkey business user expects a gentler user interface, such as has been provided by some of Radio Shack's competitors. We also have to

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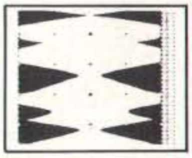

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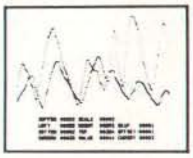

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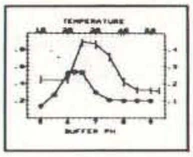

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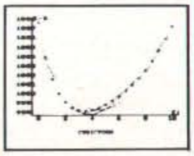

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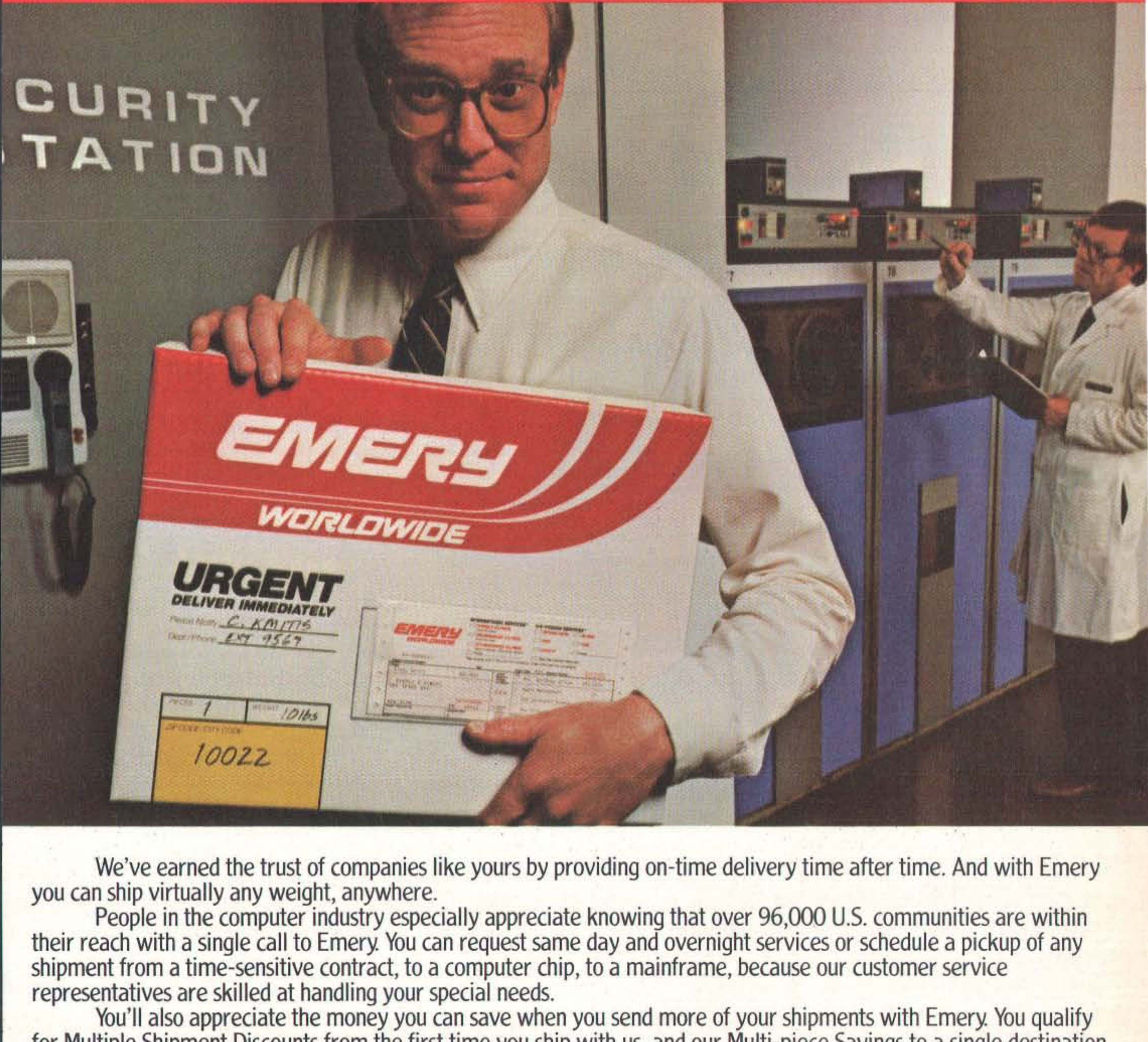

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comment on the system manuals. There are eleven of them: six for Xenix and the Development System, and five for the single-user operating systems, the assembler, and hardware owner's manuals. The manuals are long, neat, well indexed, illustrated, and index-tabbed. They are, however, rather difficult to use, especially for the intended purchasers of the machine. The documentation for the hardware and single-user software is moderately informative, but tends to brush the surface of topics that require detailed treatment. There is no clear documentation path, either. One manual says to read it first (the 16B's Operator's Manual); it deals entirely with the single-user operating systems and basic use of the machine. Although it is relatively lengthy, the Xenix documentation is only a mild improvement over standard Unix manuals. There are some custom-written sections, and the organization and indexing of the manuals is much better than for standard Unix manuals. However, we feel that naive purchasers could not use this machine without a lot of careful handholding from their dealers. We hope that Radio Shack dealers are better able to handle the complexities of Unix than are most computer retail stores today.

Conclusions

The Radio Shack TRS-80 Model 16B computer is a good competitor in the race to computerize America's small businesses. Its drawbacks for an unsophisticated user relate to the traditional Unix user interface and the lack of any real help to a novice from the large stack of manuals shipped with the system. Its advantages include good initial software offerings and the support of a very large company with many dealers and service centers. While there is certainly better executed hardware and software available in the same price category, Radio Shack has a significant potential advantage in its extensive support capabilities. It's not clear whether Radio Shack can or will invest in the educational program necessary to make sure its dealers can cope with the very sophisticated Xenix environment. The Microsoft implementation of Xenix is fairly complete and has many useful extensions to the basic Unix software set. Surprisingly, to us, the Model 16B appears to be a very good choice for people who need a small Unix development environment. Radio Shack has done a good job on this machine, and it deserves serious consideration.■

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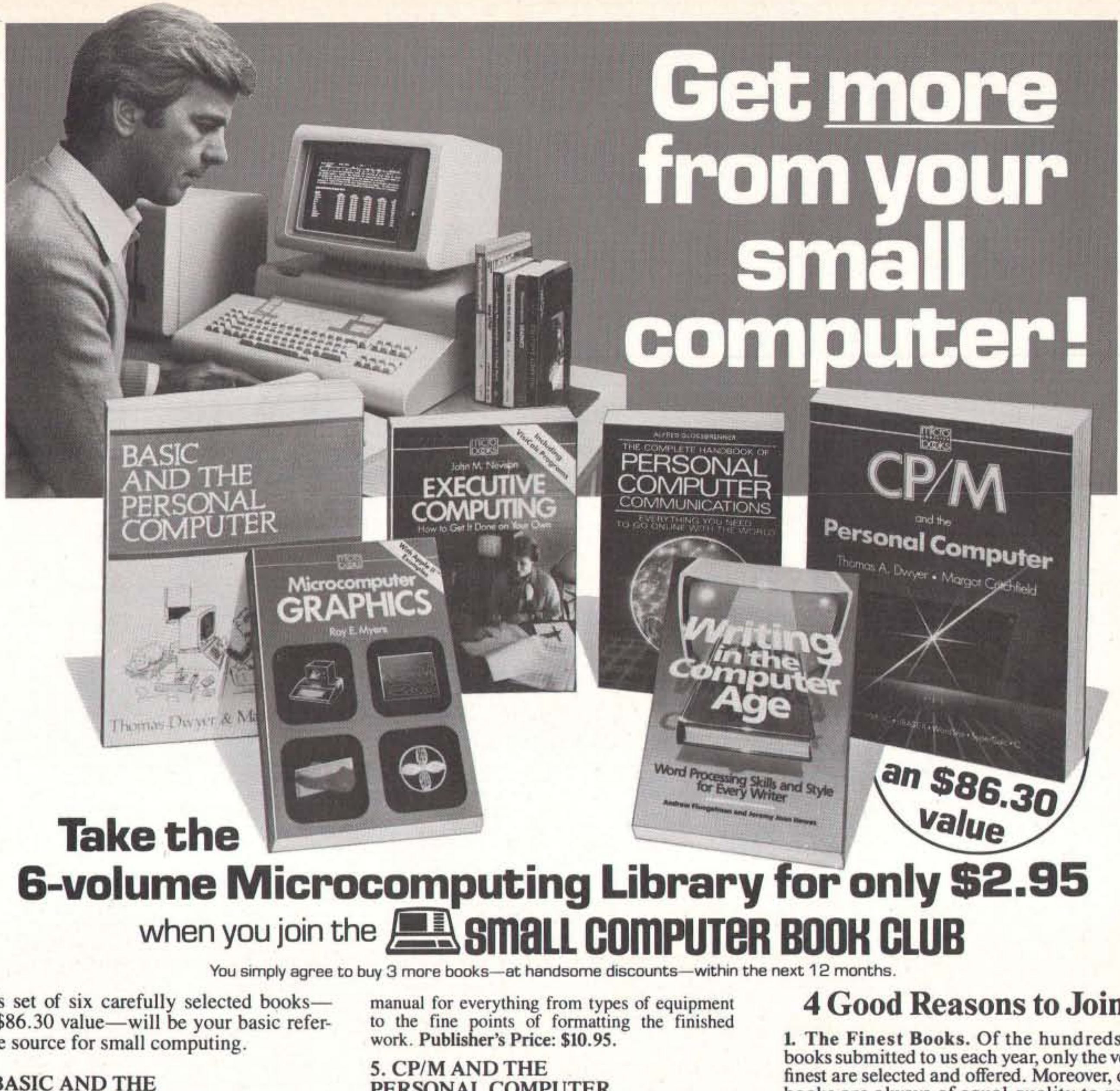
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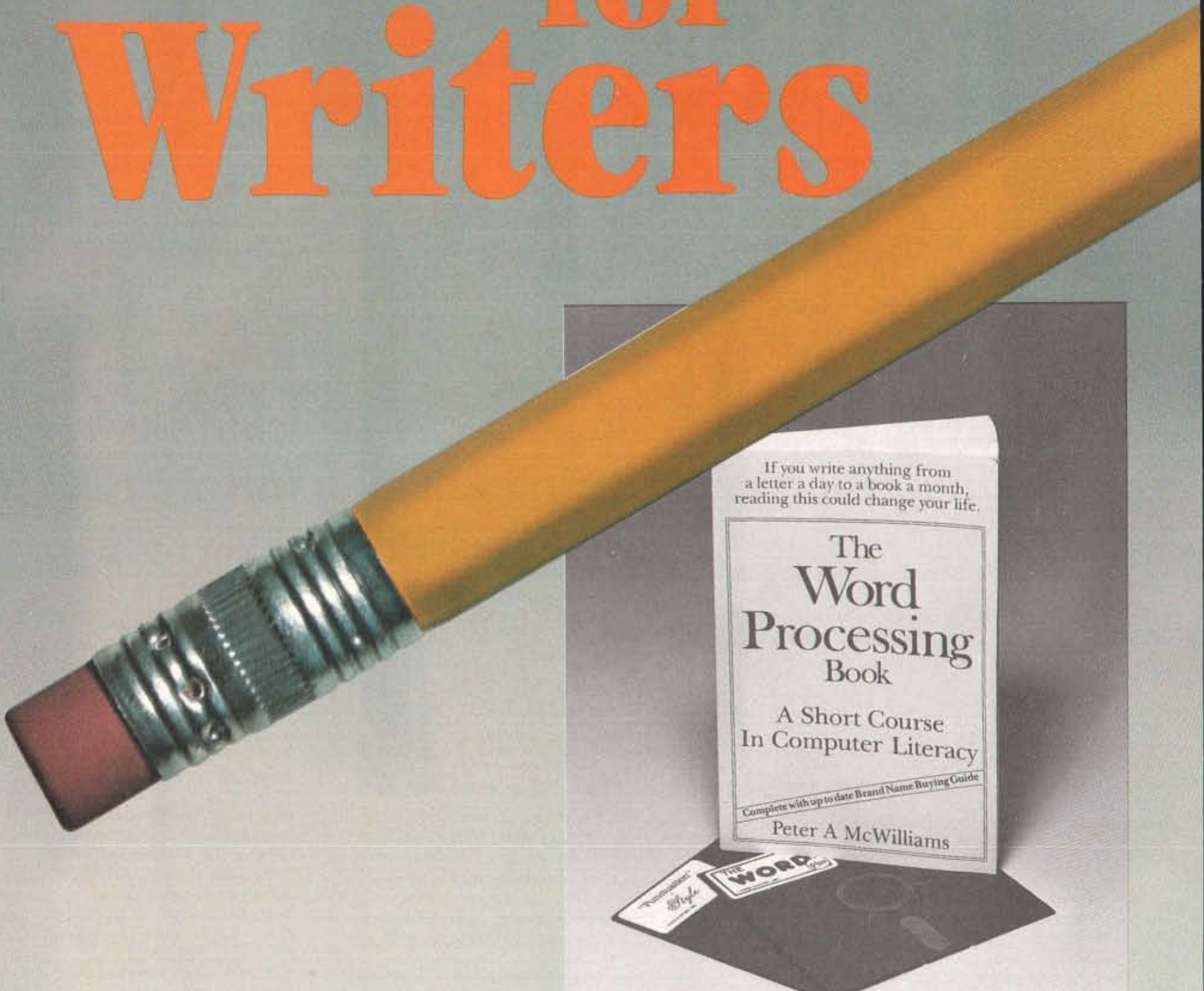
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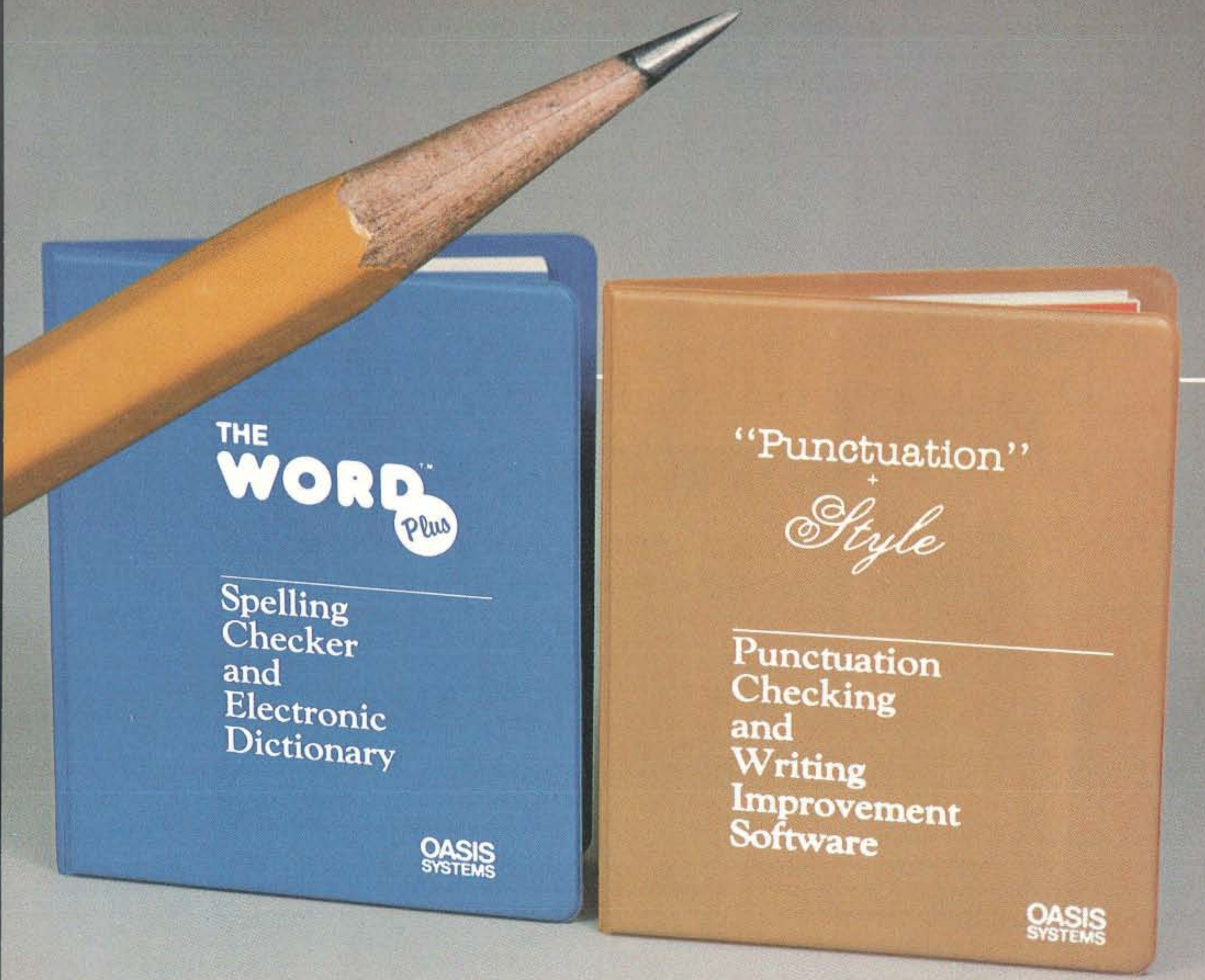

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Software Review

Naturallink to Dow Jones News/Retrieval

Texas Instruments' new software makes it easy to get complex financial information

by Mark Haas

One of the problems of the Information Age is that it isn't always easy to get the exact information you want. Several large databases, such as The Source, Compuserve, Knowledge Index, Dialog, Delphi, and others, offer their services to individual users and businesses. Each of these databases, however, works in a different way, using a unique command structure. In fact, even within a single database there may be several individual services, each working in a different way. To ease connection to one of those databases—the Dow Jones News/Retrieval Service—Texas Instruments has designed a software package that speeds and simplifies access procedures.

The Dow Jones News/Retrieval Service, a division of Dow Jones and Company Inc., which also publishes the *Wall Street Journal* and *Barron's*, is used primarily by businesses and individuals interested in business. This service provides financial information on any company listed on the New York and American stock exchanges as well as selected over-the-counter companies. You have access to 15-minute-delayed stock quotes, historical stock-quote information, disclosures, and price/volume data. The service also provides information on a large number of industries, news stories from various financial newspapers, transcripts of "Wall Street Week," movie reviews, weather information, and access to an encyclopedia. It's all in there—if you know how to access it.

The major problem with Dow Jones News/Retrieval is the cryptic way in which its information is accessed. To give you an idea of how complicated this process can get, I'll quote from the *Operating Guide* for the system:

1. Type the appropriate character to obtain the desired database.

CHARACTER	DATABASE
Comma (,)	Common and preferred stocks and warrants
Slash (/)	Corporate and foreign bonds
Plus (+)	Mutual funds
Small hyphen (-)	Options
Number (#)	U.S. treasury issues

2. Immediately type in the symbol for the desired quote. Symbols are in the *Operating Guide*. SPECIAL NOTE FOR COMMON STOCKS. To access a quote from a specific exchange, not the composite, first type in the number of the exchange and then the stock symbol. No number is required for OTC stocks.
   1 New York   3 Pacific
   2 American   4 Midwest
   To access preferred stocks add a plus (+) immediately after entering the symbol. For warrants add a percent (%) immediately after entering the symbol. For when issued stocks on the NY and AMEX, add a (@) immediately after entering the symbol, for the OTC exchange, add a V after the symbol.
3. Up to five different quotes can be obtained with each request by hitting the space bar between each symbol. Do not mix databases in a single request.
4. Hit the Return key following the last symbol in a request.

You can imagine how much time it would take you to get information for even a short list of stocks. Requests for other types of information have a similarly cryptic nature.

Enter Naturallink

Texas Instruments Data Systems Group, maker of the TI Professional Computer, has developed Naturallink to

At A Glance

Name
Naturallink to Dow Jones News/Retrieval

Type
Simplified interface to the Dow Jones databases

Manufacturer
Texas Intruments Inc.
Data Systems Group
POB 1444
Houston, TX 77001
(713) 895-3000

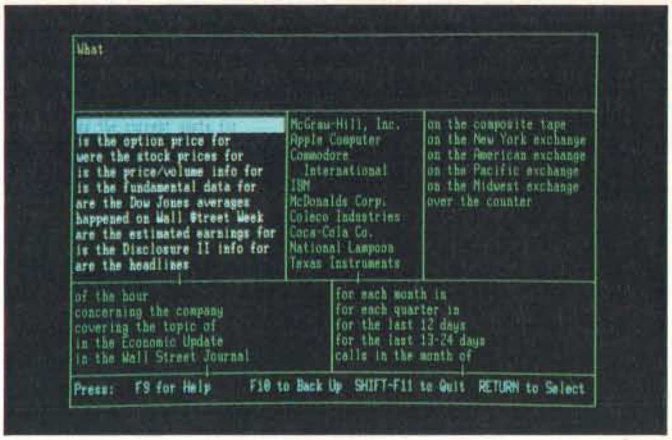
Format
Double-sided, double-density, 5¼-inch, MS-DOS formatted disk, copy-protected

Language
Machine language

Computer
TI Professional Computer with at least 256K bytes of memory, MS-DOS, an internal or external modem (asynchronous communications card needed for external modem)

Documentation
User Guide, approximately 60 pages

Price
$150 (includes Dow Jones membership)



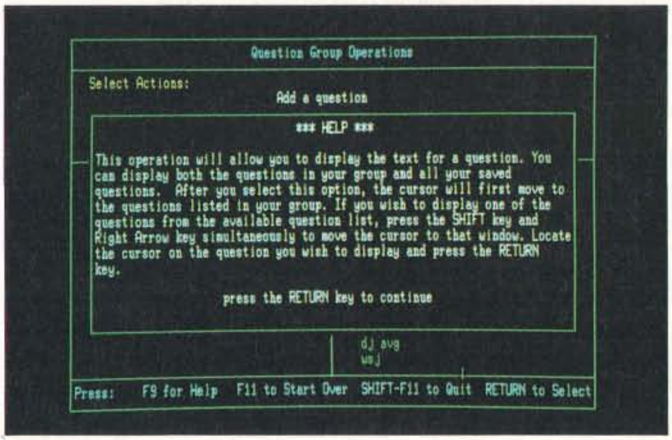
```
What

[illegible]                      McGraw-Hill, Inc.     on the composite tape
is the option price for          Apple Computer        on the New York exchange
were the stock prices for        Commodore             on the American exchange
is the price/volume info for       International       on the Pacific exchange
is the fundamental data for      IBM                   on the Midwest exchange
are the Dow Jones averages       McDonalds Corp.       over the counter
happened on Wall Street Week     Coleco Industries
are the estimated earnings for   Coca-Cola Co.
is the Disclosure II info for    National Lampoon
are the headlines                Texas Instruments

of the hour                          for each month in
concerning the company               for each quarter in
covering the topic of                for the last 12 days
in the Economic Update               for the last 13-24 days
in the Wall Street Journal           calls in the month of

Press:   F9 for Help     F10 to Back Up  SHIFT-F11 to Quit  RETURN to Select
```

Photo 1: *The Build Questions screen is the heart of the Naturallink system. Divided into windows, each window contains a specific set of phrases that are combined to form English-like sentences used to query the Dow Jones database. Small arrows at the bottom of some windows indicate that more phrases exist and can be scrolled into the window. The window across the top of the screen is used to view the progress of the sentence being constructed. The narrow window across the bottom of the screen contains information on controlling the system with the function and other keys. The stock list can be customized to your particular needs.*



```
                         Question Group Operations

Select Actions:
                            Add a question

                              *** HELP ***

  This operation will allow you to display the text for a question. You
  can display both the questions in your group and all your saved
  questions.  After you select this option, the cursor will first move to
  the questions listed in your group. If you wish to display one of the
  questions from the available question list, press the SHIFT key and
  Right Arrow key simultaneously to move the cursor to that window. Locate
  the cursor on the question you wish to display and press the RETURN
  key.

                    press the RETURN key to continue

                                   dj avg
                                   wsj

Press:   F9 for Help  F11 to Start Over  SHIFT-F11 to Quit  RETURN to Select
```

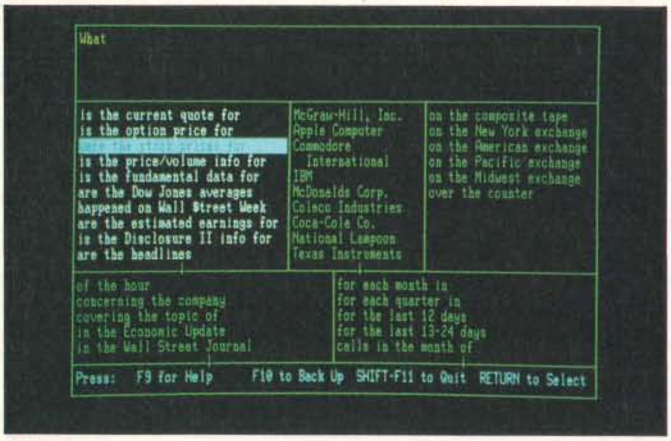
Photo 2: *Context-sensitive Help screens can be called up at any time by pressing the F9 key. Further help is available to explain the purpose of an entire screen or window by pressing Shift-F9. Help appears on the screen in its own window as shown.*

make the user's interaction with Dow Jones News/Retrieval more natural. This package provides owners of the TI Professional Computer with an easy-to-use method for retrieving information from the Dow Jones database. It will dial the phone, log you onto Tymnet or Telenet (Canadian subscribers, however, must log on to Datapac manually), and even use your password to connect you to Dow Jones. It can then query the database with questions you have previously set up, store the resulting data, and get you off line in a fraction of the time you would need to complete the process manually—with a resulting cost savings, too.

Naturallink's best feature, however, is that it enables you to build English-like questions that are then converted by the software into the cryptic commands used by Dow Jones. This works as follows: from the main menu, the Build Questions option presents you with the screen shown in photo 1. The topmost window contains the word "What" and is used to show the present state of the question being built. Each of the other windows contains a list of phrases used to construct queries. Queries to the database are constructed by selecting from the several groups of phrases shown to form complete sentences. Queries can be built off line and stored either individually or in groups for later use.

Phrases are selected from each window by use of the cursor. Initially, the cursor is on the first entry in the upper left-hand window, just below the word "What." All questions must begin with a phrase selected from this window. The cursor can be moved up and down within the window by using the up and down cursor keys. It can also move from the first to the last phrase and back by use of the Home key. Additional phrases scroll into the window when the cursor is at the bottom of the window.

To select a phrase, all you have to do is move the cursor over the phrase and press the Return key. The selected phrase is then added to the contents of the topmost window, where you can see how the question you are constructing is progressing. At any point you can press the F9 key to get help on a particular phrase, and a window containing the help information will appear on the screen (photo 2); alternatively, you can press Shift-F9 to get an explanation of the particular window you are in. You can also press F10 to back up, or undo, the question you are constructing.



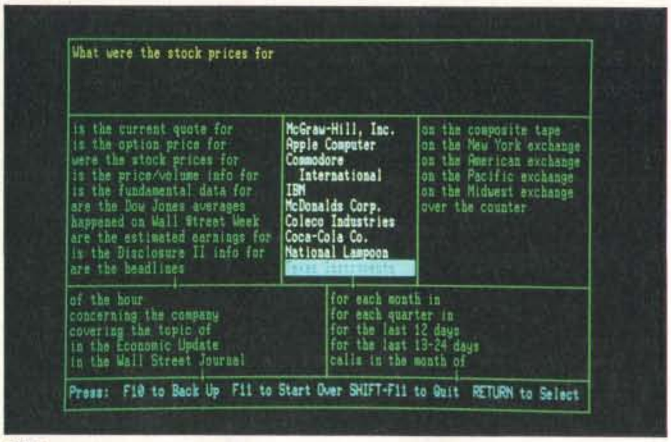
```
What

is the current quote for        McGraw-Hill, Inc.    on the composite tape
is the option price for         Apple Computer       on the New York exchange
were the stock prices for       Commodore            on the American exchange
is the price/volume info for      International      on the Pacific exchange
is the fundamental data for     IBM                  on the Midwest exchange
are the Dow Jones averages      McDonalds Corp.      over the counter
happened on Wall Street Week    Coleco Industries
are the estimated earnings for  Coca-Cola Co.
is the Disclosure II info for   National Lampoon
are the headlines               Texas Instruments

of the hour                          for each month in
concerning the company               for each quarter in
covering the topic of                for the last 12 days
in the Economic Update               for the last 13-24 days
in the Wall Street Journal           calls in the month of

Press:  F9 for Help    F10 to Back Up  SHIFT-F11 to Quit  RETURN to Select
```

(3a)



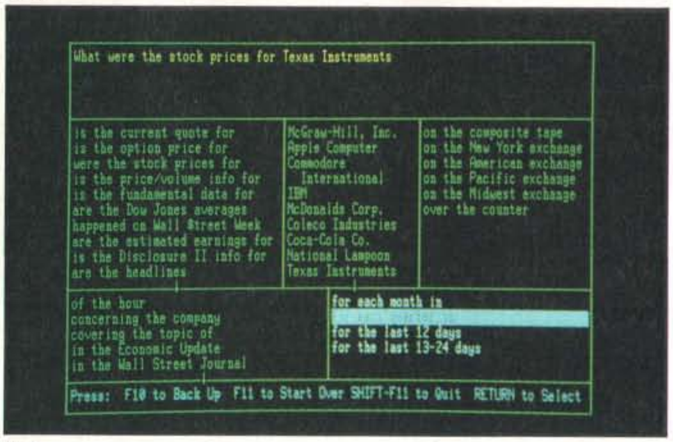
```
What were the stock prices for

is the current quote for        McGraw-Hill, Inc.    on the composite tape
is the option price for         Apple Computer       on the New York exchange
were the stock prices for       Commodore            on the American exchange
is the price/volume info for      International      on the Pacific exchange
is the fundamental data for     IBM                  on the Midwest exchange
are the Dow Jones averages      McDonalds Corp.      over the counter
happened on Wall Street Week    Coleco Industries
are the estimated earnings for  Coca-Cola Co.
is the Disclosure II info for   National Lampoon
are the headlines               Texas Instruments

of the hour                          for each month in
concerning the company               for each quarter in
covering the topic of                for the last 12 days
in the Economic Update               for the last 13-24 days
in the Wall Street Journal           calls in the month of

Press:  F10 to Back Up  F11 to Start Over SHIFT-F11 to Quit  RETURN to Select
```

(3b)



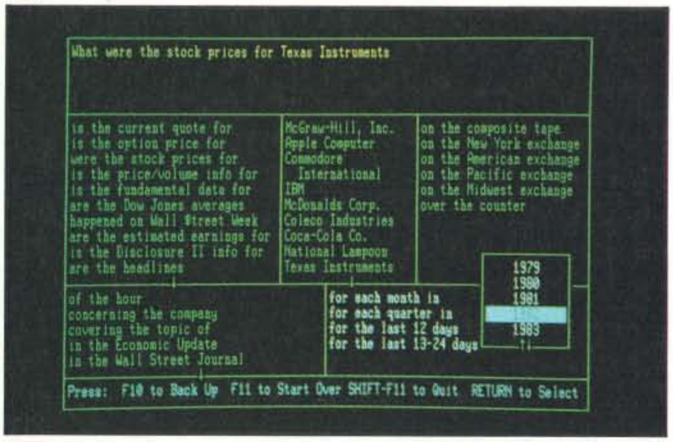
```
What were the stock prices for Texas Instruments

is the current quote for        McGraw-Hill, Inc.    on the composite tape
is the option price for         Apple Computer       on the New York exchange
were the stock prices for       Commodore            on the American exchange
is the price/volume info for      International      on the Pacific exchange
is the fundamental data for     IBM                  on the Midwest exchange
are the Dow Jones averages      McDonalds Corp.      over the counter
happened on Wall Street Week    Coleco Industries
are the estimated earnings for  Coca-Cola Co.
is the Disclosure II info for   National Lampoon
are the headlines               Texas Instruments

of the hour                          for each month in
concerning the company               for each quarter in
covering the topic of                for the last 12 days
in the Economic Update               for the last 13-24 days
in the Wall Street Journal

Press:  F10 to Back Up  F11 to Start Over SHIFT-F11 to Quit  RETURN to Select
```

(3c)

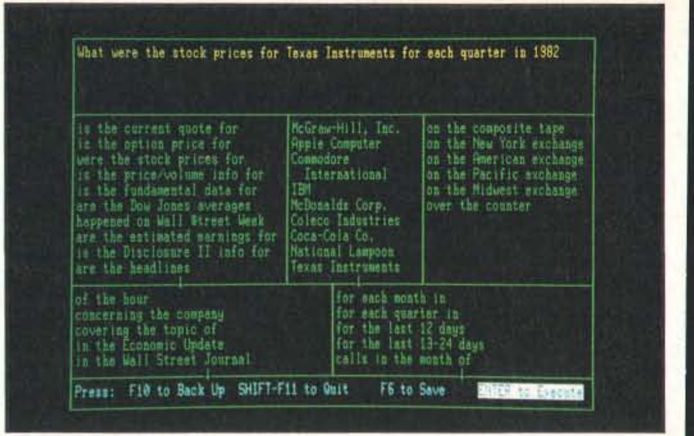


```
What were the stock prices for Texas Instruments

is the current quote for        McGraw-Hill, Inc.    on the composite tape
is the option price for         Apple Computer       on the New York exchange
were the stock prices for       Commodore            on the American exchange
is the price/volume info for      International      on the Pacific exchange
is the fundamental data for     IBM                  on the Midwest exchange
are the Dow Jones averages      McDonalds Corp.      over the counter
happened on Wall Street Week    Coleco Industries
are the estimated earnings for  Coca-Cola Co.
is the Disclosure II info for   National Lampoon
are the headlines               Texas Instruments              1979
                                                               1980
of the hour                          for each month in         1981
concerning the company               for each quarter in       1982
covering the topic of                for the last 12 days      1983
in the Economic Update               for the last 13-24 days    ↑↓
in the Wall Street Journal

Press:  F10 to Back Up  F11 to Start Over SHIFT-F11 to Quit  RETURN to Select
```

(3d)



```
What were the stock prices for Texas Instruments for each quarter in 1982

is the current quote for        McGraw-Hill, Inc.    on the composite tape
is the option price for         Apple Computer       on the New York exchange
were the stock prices for       Commodore            on the American exchange
is the price/volume info for      International      on the Pacific exchange
is the fundamental data for     IBM                  on the Midwest exchange
are the Dow Jones averages      McDonalds Corp.      over the counter
happened on Wall Street Week    Coleco Industries
are the estimated earnings for  Coca-Cola Co.
is the Disclosure II info for   National Lampoon
are the headlines               Texas Instruments

of the hour                          for each month in
concerning the company               for each quarter in
covering the topic of                for the last 12 days
in the Economic Update               for the last 13-24 days
in the Wall Street Journal           calls in the month of

Press:  F10 to Back Up  SHIFT-F11 to Quit    F6 to Save    ENTER to Execute
```

(3e)

Photo 3: *In this sequence, a question is constructed by selecting phrases from the various windows using the cursor. Here, the question "What were the stock prices for Texas Instruments for each quarter in 1982?" is being built. Note that as each phrase is selected, the cursor automatically moves to the next appropriate window. You cannot build invalid questions. After the last phrase is added (in photo 3e), you can execute the question or save it to disk using the F6 key.*

Phrases can also be chosen by typing the first letter of a phrase. If more than one phrase begins with this letter, the cursor will move to the first entry with this letter. Typing the second letter of the phrase will move the cursor again, until you have identified a unique phrase. This procedure usually doesn't take more than two keystrokes.

After you have selected a phrase, the cursor will then move to the next appropriate window, depending on which phrase you have selected. In some cases, merely selecting a phrase from the first window will complete a query, such as "What happened on 'Wall Street Week'?" or "What movie reviews are available?" Sometimes additional windows will appear on the screen. The sequence of screens shown in photo 3 demonstrates how you can build a question using phrases from several windows.

After a question is complete, it can be saved by pressing the F6 key. Questions are stored individually at first but can be arranged in groups later from the main menu by selecting the Get Saved Questions option.

Most of the queries on Dow Jones will inevitably revolve around a selected group of companies listed on the various stock exchanges. Normally, this would involve having the codes for these companies handy. The Naturallink system allows you to build your own personalized group of stocks so that you can eliminate the constant necessity of looking up stock codes (remember, there are 6000 of them). The Create or Change Stock List option on the main menu takes you there. As with the rest of the Naturallink system, this operation is entirely menu driven with choices designated by the cursor. Besides creating a new group of stocks, an existing group can be modified. The stock group you create is eventually saved on disk and then appears in one of the windows of the Build Questions screen.

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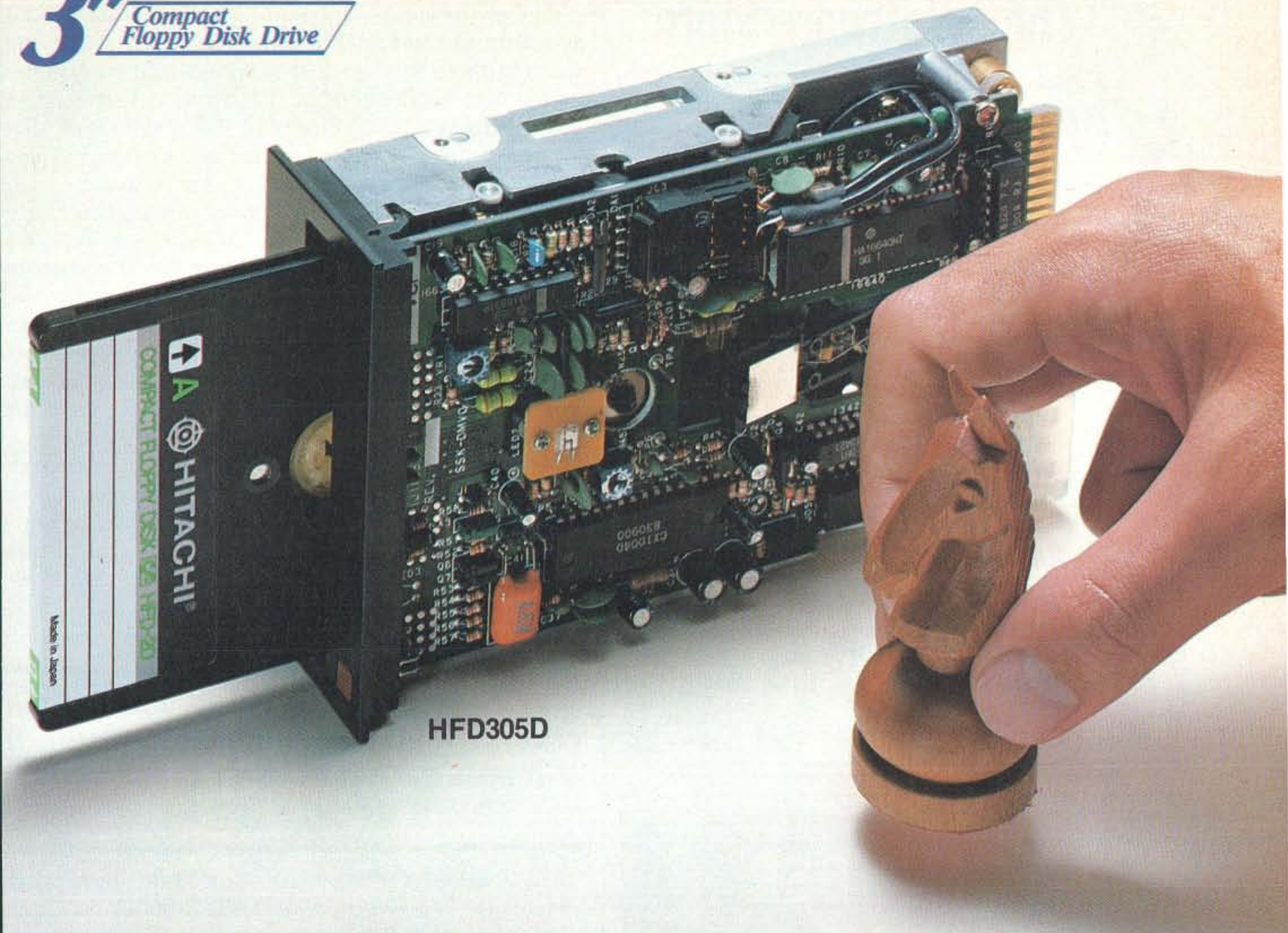

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The User Interface

Though the entire Naturallink system could be viewed as a user interface to Dow Jones News/Retrieval, I will limit my discussion here to the way in which the Naturallink system itself operates. It is obvious that a lot of thought went into the design of this system, not only to create a useful tool for accessing information, but also to make it work in a way that is easy to use.

Naturallink, however, is *not* really a natural-language system. It does not interpret sentences you type in. Rather, TI has analyzed the Dow Jones system and established a finite group of phrases that, when strung together in permissible combinations, form English-like sentences that can be converted into the symbols understood by the Dow Jones system. These phrases, the decision tables associated with them that determine what combinations of phrases are valid, and the corresponding symbols understood by the database are stored in separate files on disk. There is every reason to believe that the kernel of this software package could be used with different phrase, decision-table, and symbol files to provide a similar interface to a variety of databases. This may be only the first in a series of Naturallink packages.

The software prevents you from choosing an inappropriate action: if a menu option doesn't make sense, it doesn't appear.

The developers of the Naturallink system have taken advantage of every feature of the TI Professional Computer. Naturallink is a large system, requiring 256K bytes of memory. A program such as this could exist only on a 16-bit computer. Also, color is used throughout to provide status information. For instance, the active window on the Build Questions screen has white type, while the inactive windows have green type. A gentle beep of the speaker warns of inappropriate actions. The TI PC's ability to mix text and graphics is used throughout to present information on the screen in an organized way through the use of windows. Function keys provide one-stroke action on certain commands.

All this is achieved in a completely consistent way. The same keys perform the same functions no matter where you are in the system. Menu choices are selected by moving the cursor over the desired action and then pressing the Return key. The software prevents you from choosing an inappropriate action. You cannot, for example, ask for the weather on the New York stock exchange. Furthermore, the menus themselves are dynamic. If, for example, you haven't yet built a group of questions, then the Delete a Group of Questions option does not appear on any of the menus. In all cases, if a menu option doesn't make sense given a particular set of circumstances, it doesn't appear.

It is generally recognized that a menu-driven system

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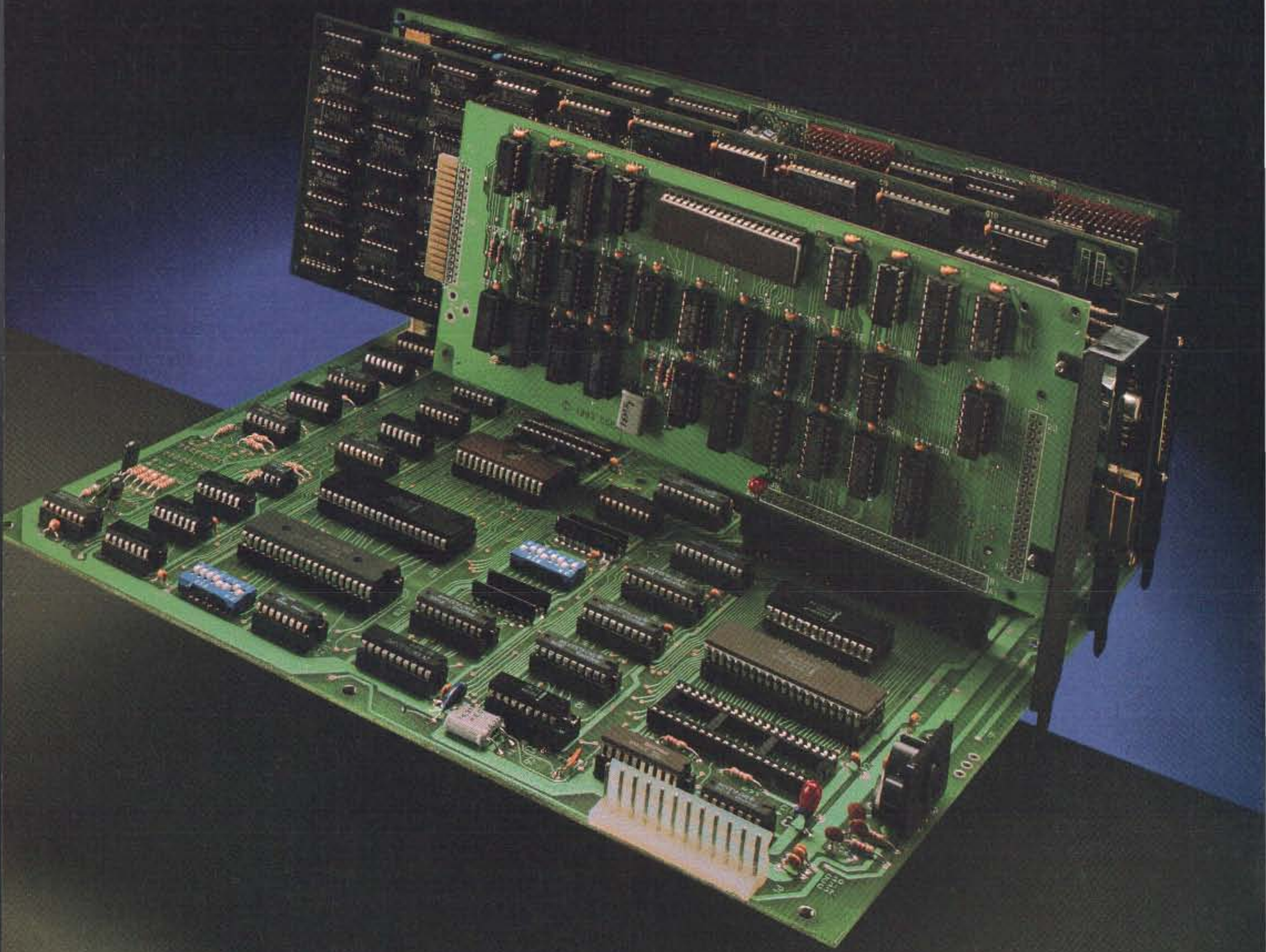

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is easy for the uninitiated to use but tends to slow down the more experienced user. As mentioned earlier, TI has taken this into consideration by allowing you to choose menu options by typing the first letter of that option. If more than one option begins with the same letter, then you have to keep typing until you have uniquely defined the option. Again, this usually requires no more than two keystrokes. Combined with the TI Professional's ability to buffer keyboard input, you could enter a series of commands rapidly while the system is fetching data from disk and it will catch up to you.

Anyone who has used the popular new generation of spreadsheet programs—for example, Lotus Development Corporation's 1-2-3 or Microsoft's Multiplan—is familiar with the use of the cursor I have just described and the keystroke option, too. Where Naturallink departs from these other programs is in its ability to use this method to also select from Dow Jones menus, menus that are not an integral part of the Naturallink software. For example, let's say you've just asked the database, "What are the headlines concerning the company IBM?" Dow Jones will then send you about five screens full of headlines (which change almost every day). If you want to read the text of the story, you normally have to enter one of the two-letter codes appearing next to each headline. Naturallink, however, provides you with a cursor to make your choice. All you have to do is scan the headlines with the cursor and press Return when you want to read a particular story. How TI does this is beyond me, but it makes the process of receiving stories extremely easy. After reading the story, you merely press F10 to bring you back to the list of headlines—at the same point where you left it—and continue to scan.

The Naturallink system, in essence, provides you with the same method of selecting information from Dow Jones as it does with its own menus. Manual selection of menu items by entering certain keystrokes is not supported directly, however, but it can be done by entering what is called "terminal" mode.

There are, however, a few places on Dow Jones where you cannot get all the information you want via cursor selection. For example, after you ask the question, "What weather data is available?" Dow Jones presents you with a short menu of selections, and Naturallink lets you choose the desired item by moving the cursor. Below this menu, though, is the instruction to enter N for national weather or F for foreign weather. These letters must be entered manually. Naturallink allows you to shift into "terminal" mode very easily, however. All you have to do is press F12. Then you just enter your choice manually. When the next menu appears, you're back in "automatic" mode and can again choose by using the cursor.

At present, Naturallink's cursor selection capability is not available for Dow Jones' encyclopedia database or for its free-text mode. These services must be accessed manually.

Setting Up

The Naturallink system is provided on a 5¼-inch copy-protected disk. TI rationalizes the use of copy protection by stating that it is for your own good, preventing unauthorized use of your Dow Jones account, thus acting as a key of sorts.

You are provided with two copies of the master disk and directed to make a working copy on another disk or transfer the files to a hard disk. When you subsequently start the program, one of the master disks must be in the A drive, but only until the main menu appears. I had some problems copying the files onto the hard disk, but eventually they all made it.

If a company wants to protect its software, fine, but it shouldn't try to convince us that it's for our own good. At least TI provides two copies of the master disk, and this disk is used for only the briefest moment during startup. Other companies force you to use the master as the working copy.

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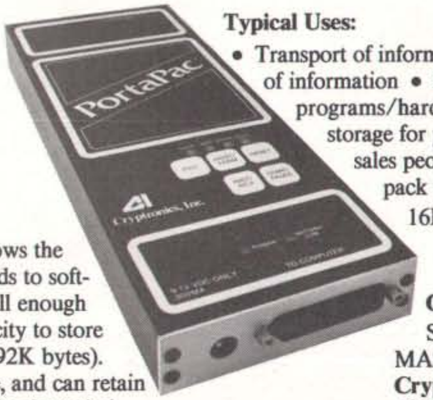

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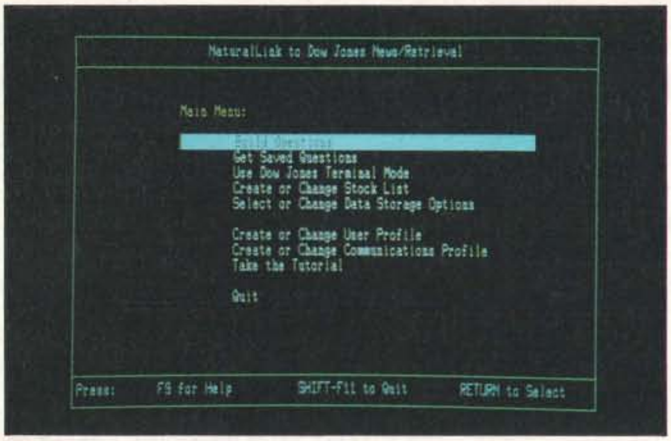

NaturalLink to Dow Jones News/Retrieval
Main Menu:
Build Questions
Get Saved Questions
Use Dow Jones Terminal Mode
Create or Change Stock List
Select or Change Data Storage Options
Create or Change User Profile
Create or Change Communications Profile
Take the Tutorial
Quit
Press: F9 for Help SHIFT-F11 to Quit RETURN to Select

Photo 4: *After logging onto Naturallink, you are presented with the Main Menu. From here you can perform the various functions listed. Only those functions that can be performed appear on the menu. For instance, the Get Saved Questions option appears on the menu only when there are questions to retrieve.*

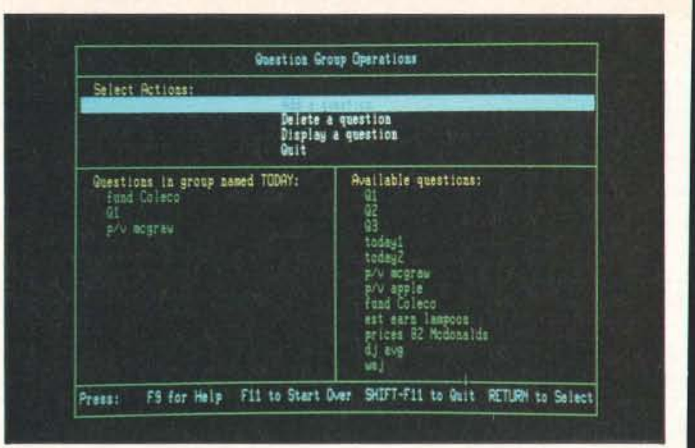
The next step is to set up your User Profile, i.e., information the system needs to establish your files. Here you give your data file a name and store your Dow Jones password. You also designate whether you want to log on automatically or manually. Automatic log on is available only for Tymnet and Telenet.

In order for the software to work properly with your system, you have to tell it what equipment you are using. Naturallink calls this process "Creating a Communications Profile." Here you can choose between internal and external modems, automatic and manual dialing, port selection, choice of network (Tymnet, Telenet, etc.), and phone number. I found it interesting that I had to manually designate the port used by my TI's internal modem. This requirement is strange because, in order to determine what port my internal modem occupied, I had to run TI's Diagnostics disk, which automatically determines the port. If the Diagnostics software can do this, why can't Naturallink?

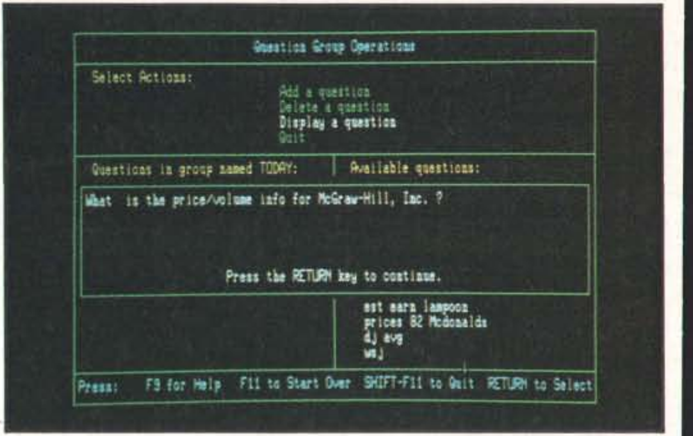
Beginners are advised to use the excellent tutorial disk provided with the system. It demonstrates the question-building process and provides a hands-on opportunity to use the system; helpful prompts even appear in one of the windows on the Build Questions screen. All in all, it provides a nonthreatening way to begin to use the software.

A Typical Session

After you've installed your user and communications profiles, a typical session with the Naturallink system begins with the construction of questions. After entering the appropriate user ID and password (different from the Dow Jones account password), you are presented with the main menu (see photo 4). If you haven't already done so, now is the time to create your own personalized group of stocks. But let's assume this has been done previously. The cursor is already over the Build Questions option, so all you have to do is press Return.



(5a)



What is the price/volume info for McGraw-Hill, Inc. ?

Press the RETURN key to continue.

est earn lampoon
prices 82 Mcdonalds
dj avg
wsj
Press: F9 for Help F11 to Start Over SHIFT-F11 to Quit RETURN to Select

(5b)

Photo 5: *Questions that have previously been saved individually from the Build Questions screen can be organized into groups from this menu. Again, only those options that are relevant appear on the menu. By organizing questions in groups, you can eliminate the need to present each question individually. At any point you can display a question's contents by placing the cursor over its name after selecting the Display Question option, as shown in photo 5b.*

The Build Questions screen, with its associated windows, appears after a couple of status messages tell you what is happening. Questions are constructed as described earlier and saved onto the disk.

One of the ways to use this system most efficiently is to arrange your questions into groups. From the main menu you select the Get Saved Questions option, which presents you with another menu. From this second menu you select the Build Question Group option. This allows you to view all the questions you saved using the Build Questions screen, arrange them in groups, give these groups names, and save them on disk. Photos 5a and 5b show this process.

Once the groups of questions have been stored, it is possible to execute a group. No, this doesn't mean lining them up and shooting them. Rather, executing a group of questions causes Naturallink to begin the process of automatically logging on to Dow Jones. First, diagnostics are performed on the the TI's asynchronous communications card or internal modem, depending on

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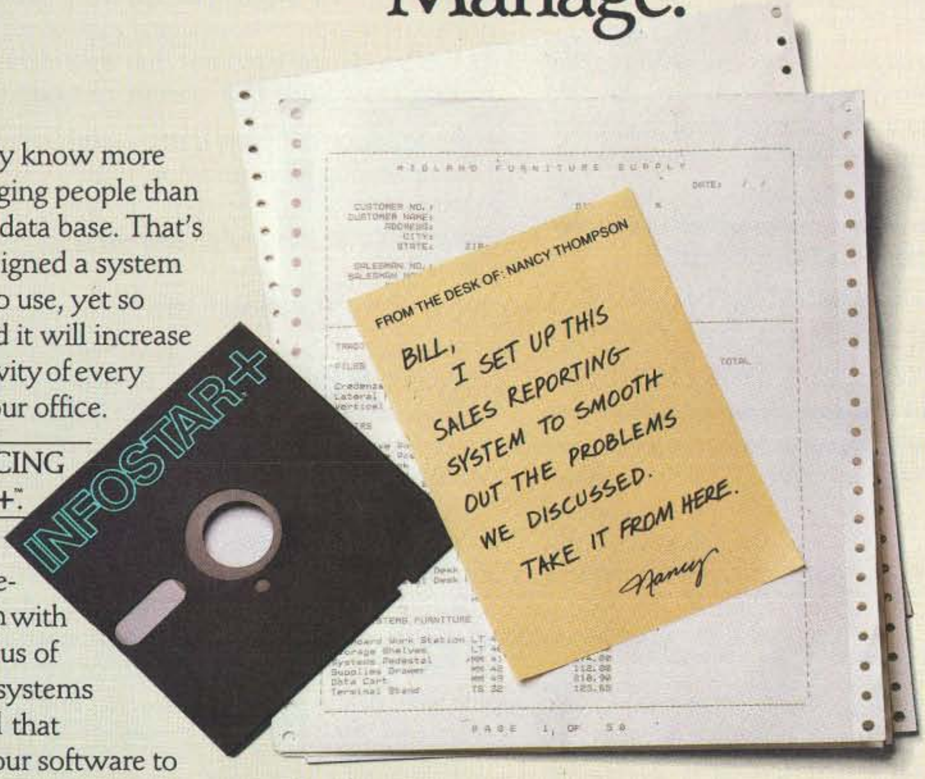

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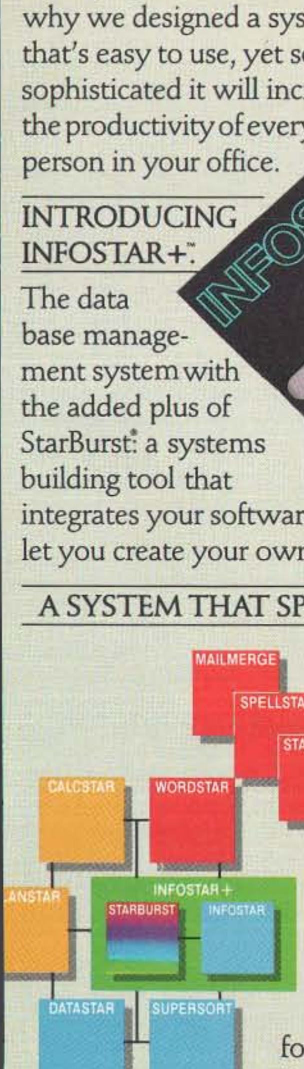

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which is being used. Next, assuming you have either the built-in modem or a programmable external one, the program dials the appropriate network, let's say Tymnet, and establishes connection. Naturallink then directs Tymnet to connect you to Dow Jones and uses your password to log you onto the system. While all this is going on, a series of status messages keeps you informed of the system's progress. After you are logged onto Dow Jones, your group of questions is presented to the system and the information you requested appears on your screen.

Instead of wasting costly connect time reading this data, however, you can simply press F6 to save the data on your disk and proceed to the next group of questions. After the last question is answered, you can disconnect and review your data file at your leisure.

An excellent tutorial disk demonstrates the question-building process and provides a hands-on opportunity to use the system.

At almost any time while connected to Dow Jones, you can call up the Build Questions screen to ask individual questions that may arise from the data you see coming in. You can also interact with the Dow Jones system manually, if you know the appropriate codes and have a masochistic streak.

Documentation

After viewing TI's new BASIC manual for the PC (see my review of the TI Professional Computer on page 286 of the December BYTE), I had high hopes for this manual. Unfortunately, this manual suffers from the same problems as most of TI's others. Although the argument could be made that the tutorial disk obviates the need for a good manual, the manual should at least be a good reference. This manual isn't. In fact, in many places it reads like advertising copy. I think the section I liked the best was entitled "Using the Main Menu Effectively." Oh boy, I thought, here's a way to get the most out of the software—perhaps some sort of strategy. Instead I read about how the *program* uses the main menu effectively by limiting the user to valid choices.

Conclusions

Now, I'm not a financial wizard. I wouldn't know a price/earnings ratio from a gear ratio. But I do know that TI has produced a system that makes retrieving information easy. With this system you can

- prepare your database queries off line at great savings
- automatically dial and log onto Dow Jones News/Retrieval
- save the data resulting from your queries for off-line review
- prepare a personalized stock list

Naturallink lets you do this with a series of menus and screens that allow even the novice to use it with ease. A tutorial provides most of the information you need to get started, and context-sensitive Help screens are available at all times.

By combining the central logic of this Naturallink package with other phrase, decision-table, and symbol files, it would seem possible for TI to develop a series of Naturallink packages for a variety of databases. To do so would mean that you could interact with a number of diverse data services through an interface that would always work in a familiar way. It could provide a "software bus" to on-line databases. Now that's something to ponder.■

Mark Haas, a former managing editor of BYTE, is technical director of Osborne/McGraw-Hill (2600 Tenth St., Berkeley, CA 94710).

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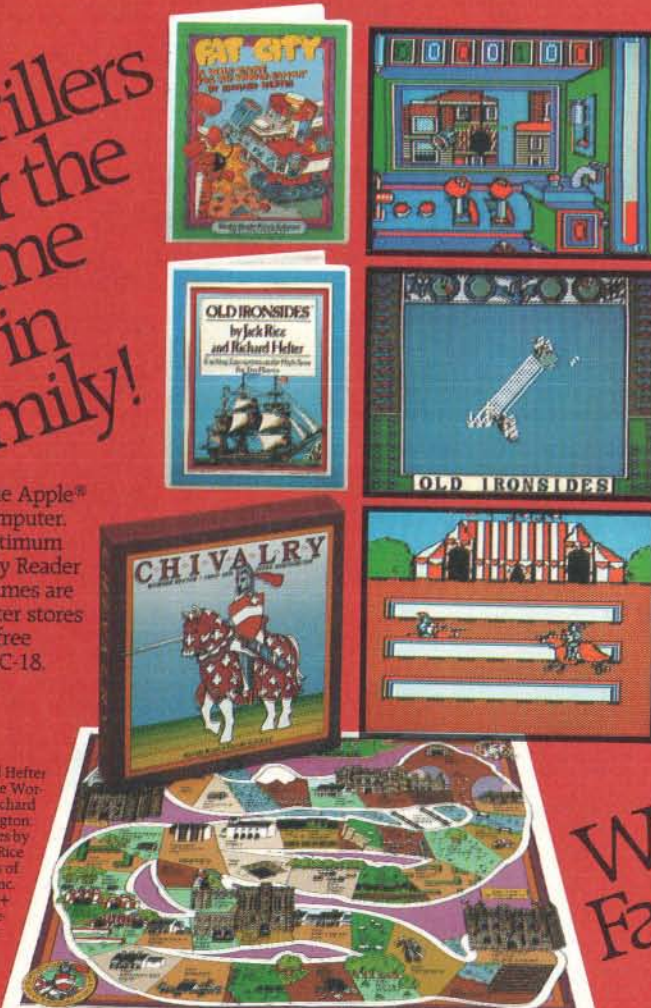

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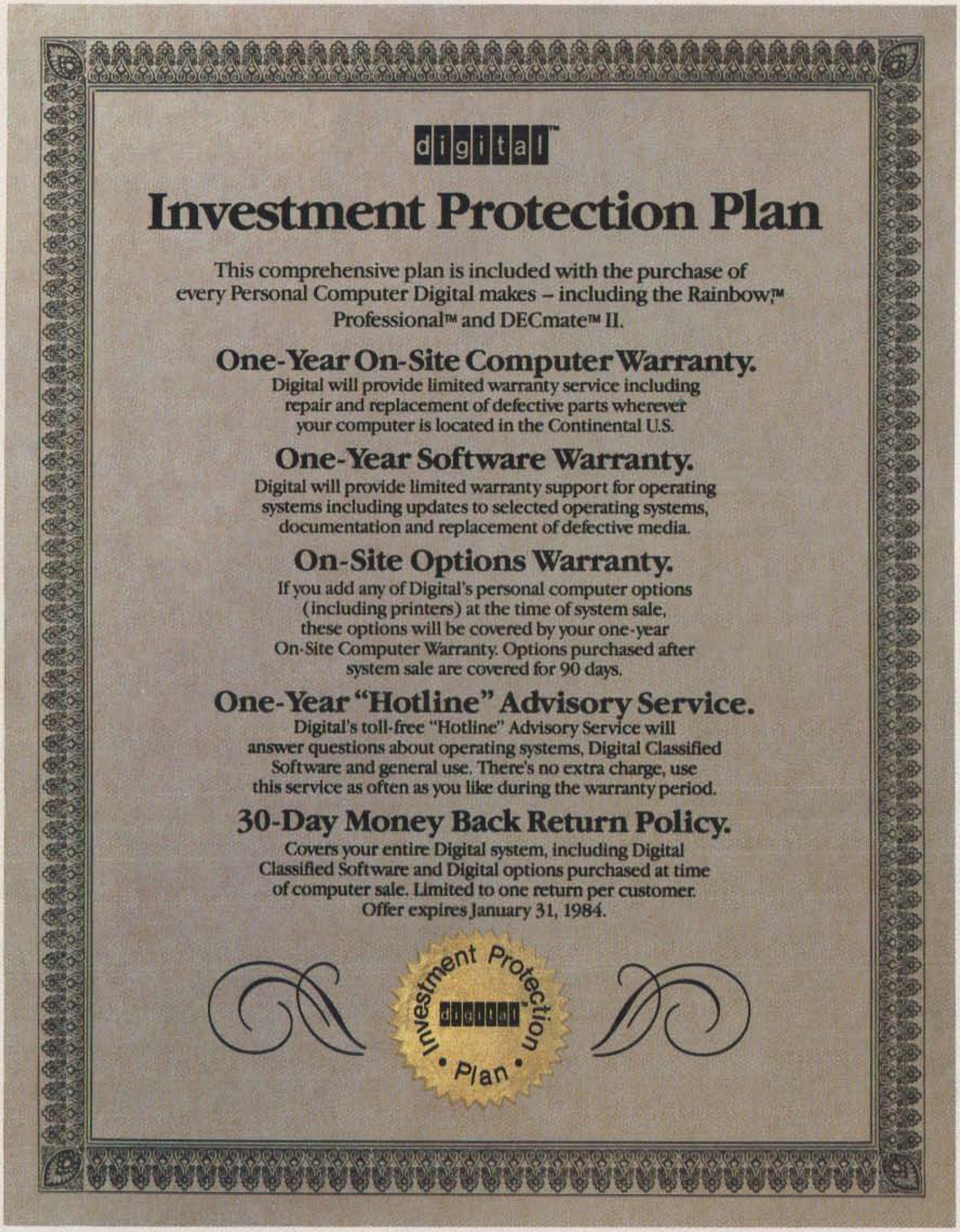

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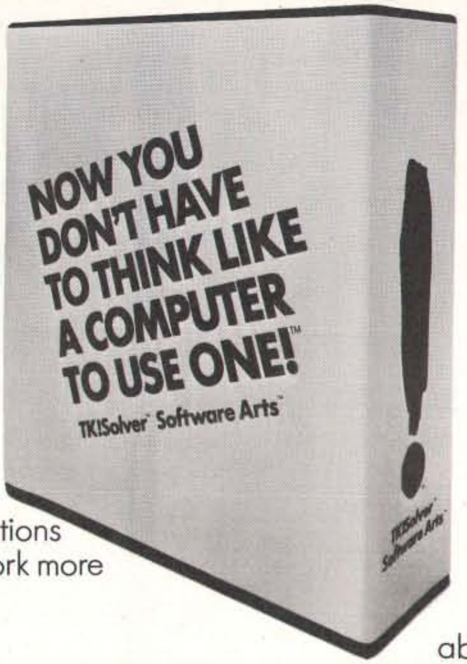
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The Vamp DVM-1 Computer/TV Interface Kit

Interface a computer's video and audio outputs directly into a TV for enhanced picture quality

by Richard F. Gillette

The DVM-1 kit can help you overcome the display degradation that often disappoints users of systems employing an RF (radio-frequency) modulator to interface a computer's video output to a standard color television. The DVM-1 lets the computer's output bypass the TV's RF section; it applies the computer's audio and video outputs directly to the TV's audio and video amplifiers, eliminating the need for an RF modulator.

Shortly after I had purchased a computer for text and graphics applications, I became disappointed with the display quality of my RF-modulator/color-TV combination. I had no right to expect better; after all, a color TV's tuner and IF (intermediate-frequency) stages pass only a 4-MHz video signal to prevent interference among adjacent TV stations; even the cheapest black-and-white monitor has twice this bandwidth. Although the 4-MHz bandwidth is fine for TV, most computer text and graphics applications require a wider bandwidth to take advantage of their higher resolution capabilities.

To solve this problem I thought I could simply bypass the TV's RF section and connect the computer signal directly into the TV's video amplifier. Right? Wrong. My TV, like most modern TVs, has its chassis connected directly to one side of the 110-V power line. TV manufacturers have eliminated the 60-Hz power transformer found on older models to make the new sets lighter and less costly. If I had input the computer's video directly into the TV, I would have burnt out the computer and given myself a potentially lethal electric shock. Obviously, safety considerations dictate isolation of some sort.

Photo 1: *The DVM-1 kit, including the instruction manual.*

My solution at the time (the DVM-1 was not yet available) was to purchase a bulky 110-V, 60-Hz isolation transformer and wire it permanently into the TV's line cord. The transformer would not fit in the TV, and when it was close to the TV's picture tube, or CRT (cathode-ray tube), it distorted the picture. I then added a jack (with an integral switch) to connect the microcomputer's video directly to the TV's video amplifier. The TV had a video test point with a composite video signal at the same level as the computer; thus, no bias was required, and unplugging the computer automatically switched the CRT back to TV. The results were spectacular. It looked almost as good as any of

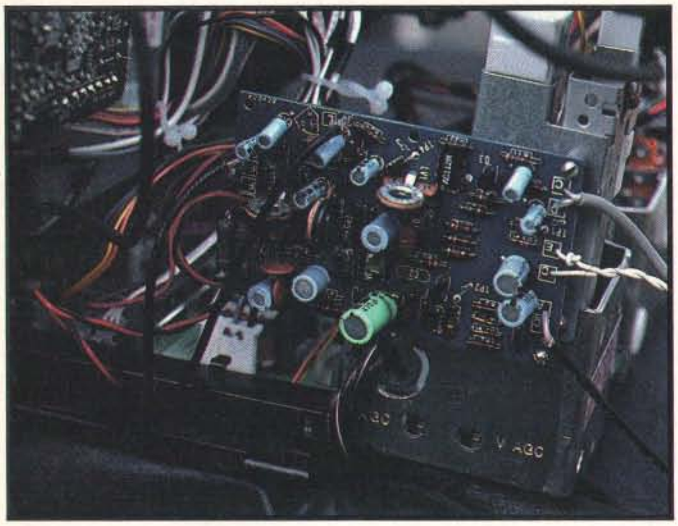

Photo 2: *The assembled DVM-1 printed-circuit board, mounted in a TV. (All photos were taken by the author.)*

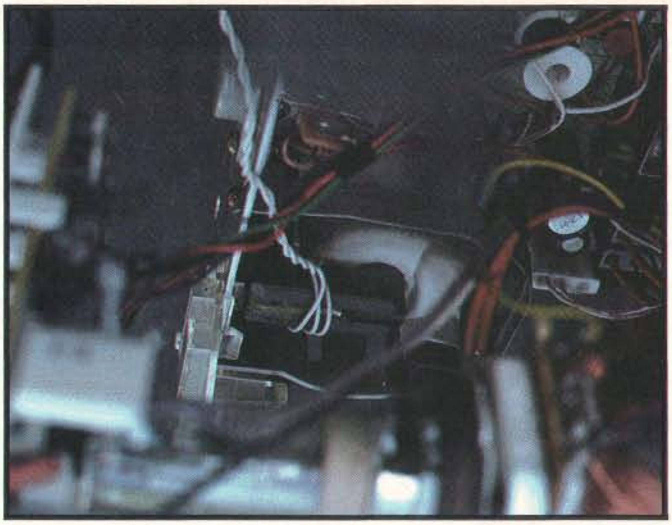

Photo 3: *The flyback-transformer pickup coil (the white twisted pair in the center of the photo) that derives power for the DVM-1 board.*

the composite video monitors I saw at the computer store. It was just as spectacular when used with a videocassette recorder.

I decided to upgrade the computer monitor from a 9-inch TV to a 12-inch Sony KV-1207 TV (my daughter was planning to take the 9-inch set to college). The larger TV required a larger isolation transformer, and while looking for this transformer I found the Vamp DVM-1. This kit provides all the circuits necessary to interface both the computer or videocassette recorder and audio directly into the TV. The required isolation is provided by a pair of optoisolators, one for video and one for audio. The conversion fits inside the TV and requires no bulky isolation transformer.

The optoisolator consists of a light-emitting diode (LED) coupled optically to a photo diode. The isolator can couple signals across a 3-kV potential difference, much more than is required for the TV set.

Another feature of the DVM-1 kit is that it uses the TV's flyback transformer to supply power for the optoisolator LEDs and their drivers, eliminating the need to take power from the computer (or videocassette recorder) or to provide a separate power supply.

The kit comes in a small box complete with all parts

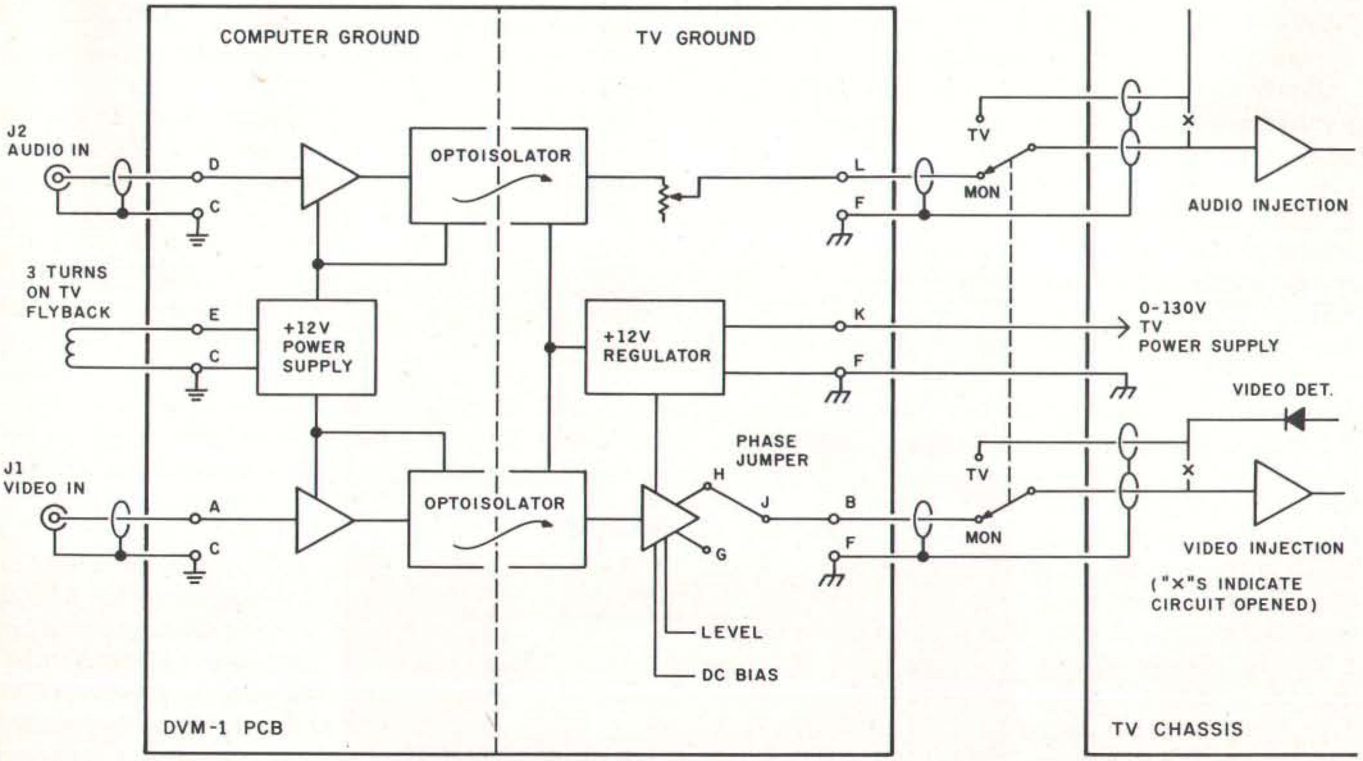

Figure 1: *The DVM-1 block diagram, showing interface wiring.*

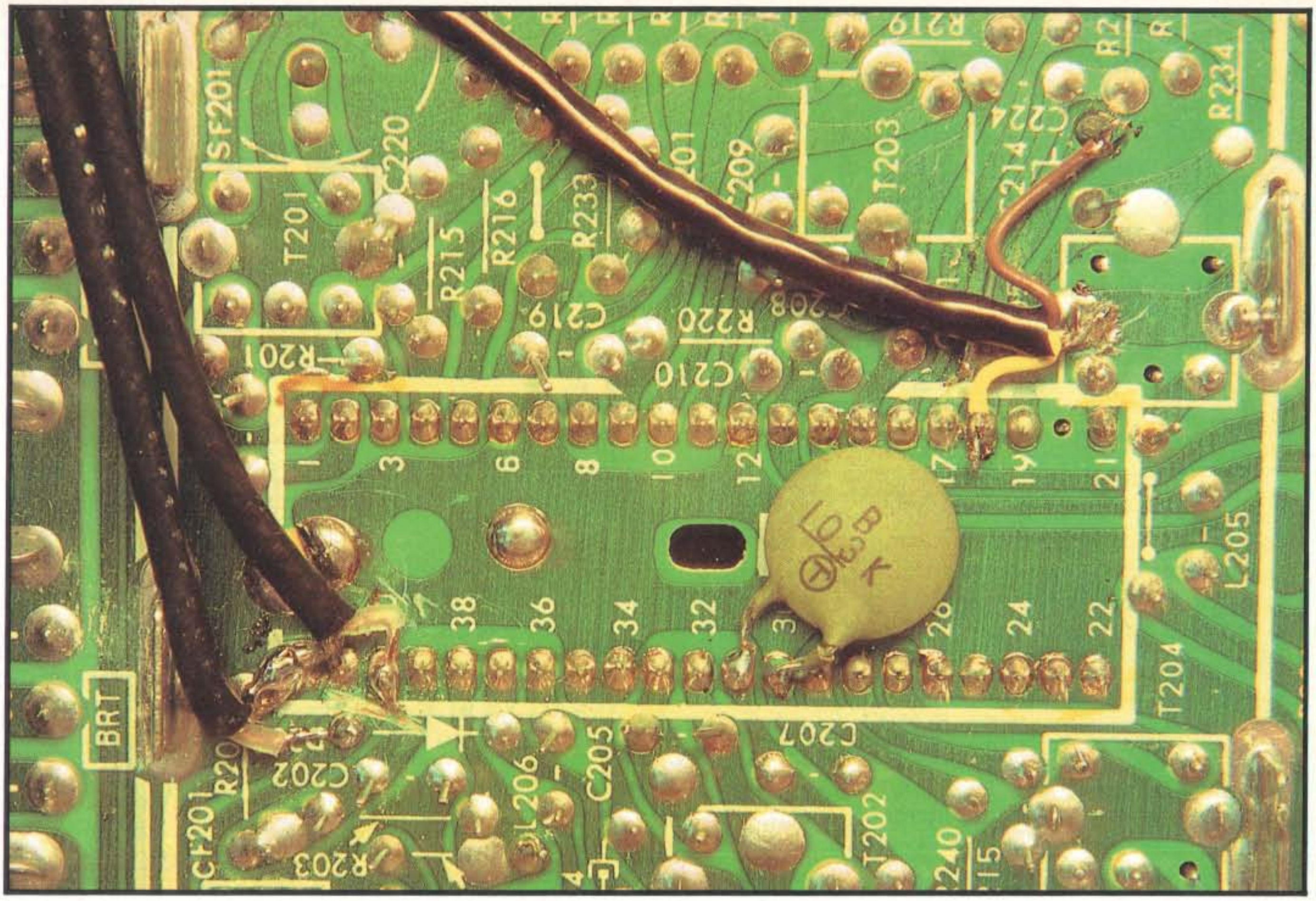

Photo 4: *Video and audio connections to the TV.*

and straightforward instructions (see photo 1). Only one printed-circuit board is involved; you just follow the parts list and insert the components into a well-marked board, solder, and trim the leads. You have to provide your own solder. The assembled printed-circuit board as mounted in my TV set is shown in photo 2.

Figure 1 shows the DVM-1 block diagram and the TV interface wiring. The combination of optoisolators and use of the TV's flyback transformer for the power supply to drive them provides complete isolation of the computer from the TV. The computer's video and audio signals are coupled across this interface (the dashed line on the block diagram in figure 1) by a light beam. No RF modulator is used, and thus cross-hatch interference due to modulator operation is eliminated from the other TVs in my home. The DVM-1 provides independent video and audio level settings and includes an adjustable bias supply for the TV's video; this feature allows an easy interface to TVs that have their video detector operating at a DC (direct current) voltage offset from ground. I needed this feature to use the DVM-1 with my Sony. (See "Add A Video Input to Your TV," *Radio-Electronics*, April 1983, for more technical details.)

Included with the kit are insulated jacks and a switch. The switch allows easy selection of either monitor or TV operation.

After the printed-circuit board is assembled, the next step is interfacing with the TV set. For this task, the DVM-1 manual provides a wealth of information. However, if you are not qualified to service your TV set, you will need help. If you are qualified or if you have a friend who is, you will have few, if any, electrical problems. The manual provides a good section on checking the kit. All parts are covered by warranty. Your challenge will be mechanical: where to mount the board, the input jacks, and the TV/monitor switch. The kit's small size enables it to fit inside any TV suitable for use as a monitor.

I am tempted to go into detail on the installation; however, each TV will pose unique requirements. My Sony KV-1207 installation is best described with pictures: photo 2 shows mounting details, and photo 3 shows the flyback-transformer pickup coil (the white twisted pair in the center of the photo) that derives the DVM-1's power. As you can see, installation was easy once I decided where to mount the hardware and route the wires. Photo 4 shows the video and audio wiring to the TV. You can see the cut video-printed circuit trace between the two coaxial cables (the audio trace that was cut cannot be seen in this photo).

After I installed the interface and adjusted the video and audio gain and the DC offset (simple procedures explained in the manual), I found that I wanted to touch

Listing 1: *A color dot-generator program written in Applesoft.*

```
10   REM   COLOR DOT GENERATOR
11   REM   * TO EXIT TYPE *
12   REM   * CTRLC RETURN *
13   REM   * TEXT RETURN   *
14   REM    R.F.GILLETTE 9/25/83
20   HGR2
30   HCOLOR= 3
40   FOR X = 0 TO 279 STEP 8
50   FOR Y = 0 TO 191 STEP 8
60   HPLOT X,Y
70   NEXT Y
80   NEXT X
90   END
```

up the TV's convergence. I followed Sony's instructions using a software-programmed dot generator. The program for an Applesoft dot generator is provided in listing 1. At my wife's urging I adjusted the TV's color so the white would appear more green, as she finds green easier on her eyes. Color monitor owners may want to try this; all that is required is to turn down the red and blue CRT drive controls.

While giving the interface a thorough checkout, including a number of RF modulator to DVM-1 comparisons, I found horizontal instabilities on large-area graphics displays output from my Apple II. The top of the graphics display had a wave (horizontal displacement), as photo 5 shows. This large-area graphics display was generated using the program from listing 1, modified by changing the step size in lines 40 and 50 from 8 to 1. Close examination revealed that the wave could appear with either the RF modulator or the DVM-1. The AC (alternating current) coupled video signal from large-area graphics upsets the DC-restore circuits in some TV sets because the sync level (most negative level) is close to the level of the video signal preceding it. This small level difference can be seen on a scope, as photo 6 shows.

At a Glance

Name
DVM-1 kit

Use
Converts a television set into a composite video (not red-green-blue) computer/videocassette record (CPU/VCR) monitor while retaining the TV function

Manufacturer
Vamp Inc.
POB 411
Los Angeles, CA 90028

Dimensions
2½ by 4 inches single-sided printed-circuit board

Price
Complete kit: $64.95 plus $2.00 shipping ($4.00 foreign)

Features
Provides wide-band video and audio channels that are isolated from a hot TV chassis; uses two optoisolators

Tools Needed
Soldering iron, screwdriver, drills (10-, 7-, and 4-mm or ⅜-, ¼-, and ⅛-inch), voltmeter, wire cutter, and schematic of TV set

Documentation
10-page manual

One solution to this problem involves a simple modification to the Apple II, and it works with both the RF modulator and the DVM-1. The video, sync, and colorburst signals are summed at the base of the Apple II's video-output transistor (Q3), which is connected as an emitter follower. Adding a fourth summing resistor (5.6KΩ, ¼W) from Q3's base to +5V increases the amplitude of the sync pulse, solving the instability. I called Apple and the person I spoke with stated that the change is not approved by Apple; hence, such modifications to your Apple will be at your own risk.

How well does the DVM-1 coupler work? Judge for

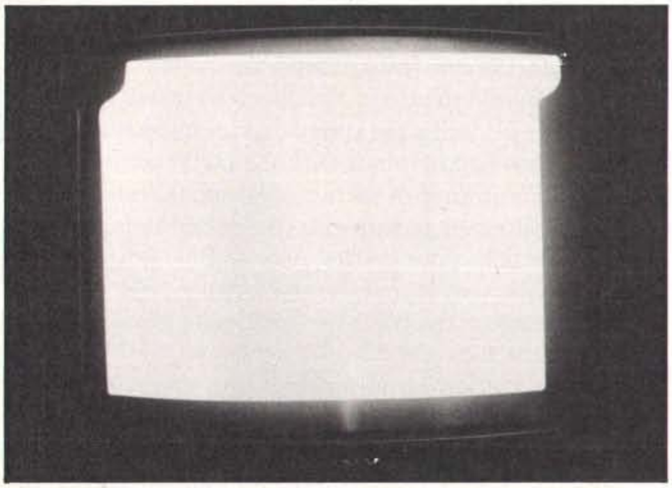

Photo 5: *A horizontal instability accompanying a large-area graphics display.*

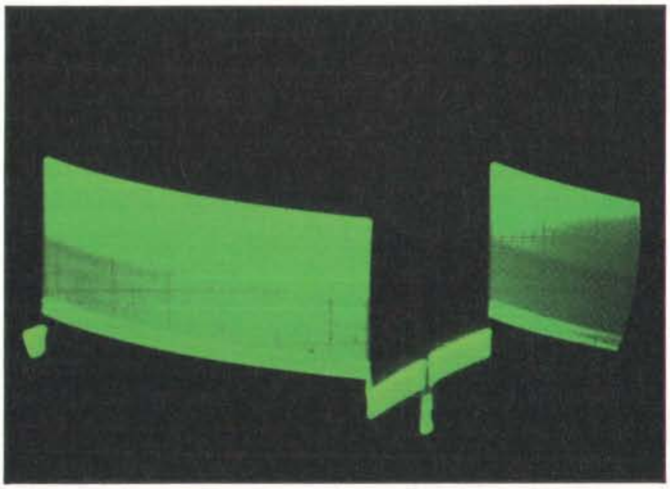

Photo 6: *A scope photo showing a large-area-graphics video signal.*

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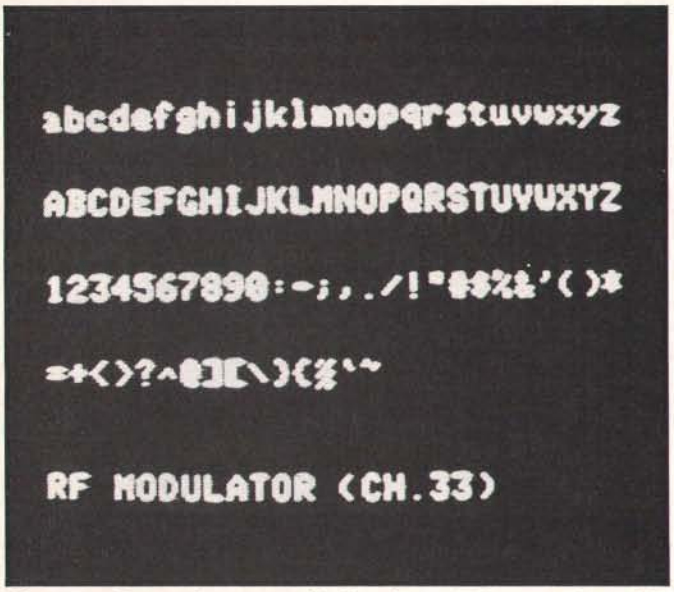

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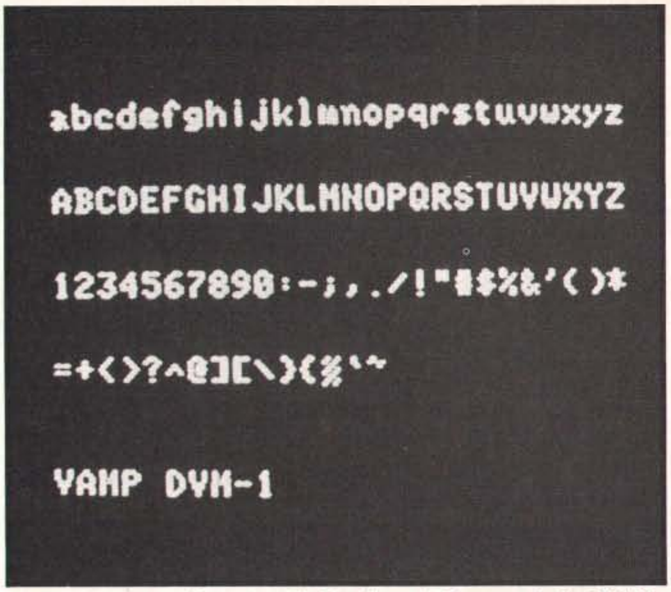
RF MODULATOR (CH.33)

Photo 7a: *Forty-column text displayed on a TV screen via an RF modulator.*



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VAMP DVM-1

Photo 7b: *Forty-column text displayed on a TV screen via the DVM-1.*

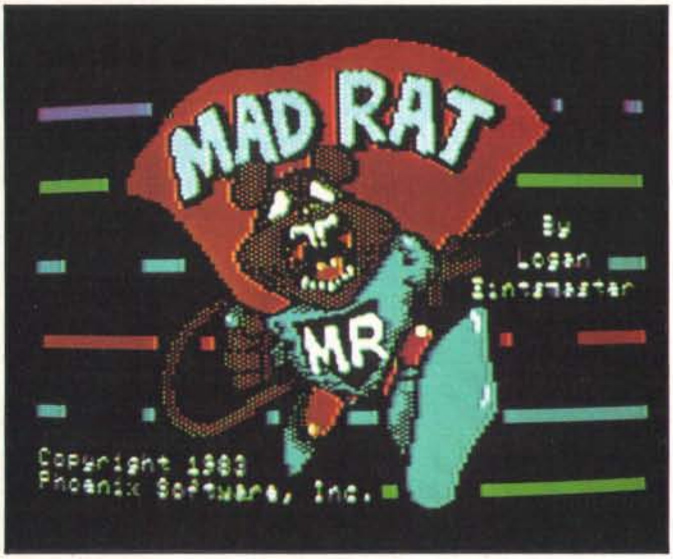

Photo 8a: *A color-graphics display interfaced to a TV via an RF modulator.*

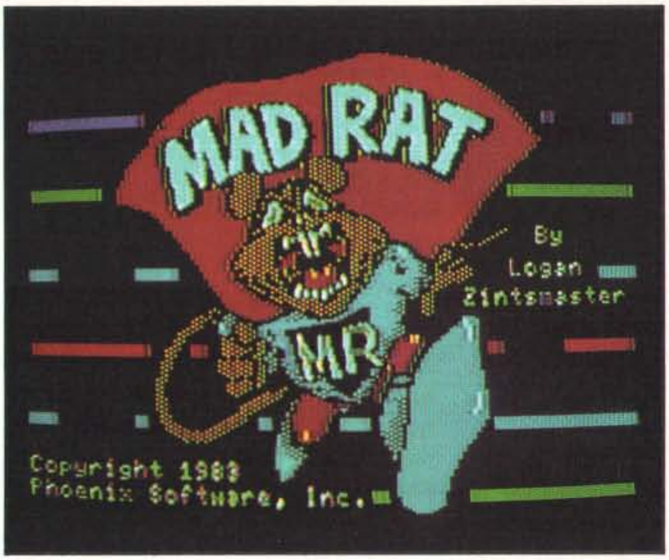

Photo 8b: *The same color-graphics display interfaced to a TV via the DVM-1.*

yourself. Photos 7a and 7b show 40-column text with the RF modulator and the DVM-1, respectively. The DVM-1 provides a bandwidth in excess of 8 MHz; mine extended past 10 MHz. These photos show the bandwidth/resolution improvement. Photo 8 shows high-resolution color graphics from the game Mad Rat (Phoenix Software), first via the RF modulator (photo 8a), then via the DVM-1 (photo 8b) (the TV was adjusted for as close a color balance as possible). The shadow mask on the screen of the color CRT reduces resolution, and TV video circuits can also reduce bandwidth. The Sony can almost, but not quite, let you use 80-column video with the DVM-1 adapter. (I tried a wider band video input and obtained the same results; the TV is the limitation.) Adding the DVM-1 to a black-and-white TV will allow 80-column operation. As you can see from the photos, my converted color TV set has the video quality of an expensive composite video monitor. The kit also provided me with an audio channel including volume control.

When considering the upgrade of a TV to a monitor, I recommend that you consult the TV's manual to make sure you understand the video and audio circuits before you invest in the DVM-1. If you do understand the circuits, then I wholeheartedly recommend this kit. One note of caution: the TV set's warranty may be voided by this monitor conversion. (My applause to Vamp, as it noted the warranty problem in its manual.) A letter to the TV manufacturer, however, may get you conversion approval. In any case, most warranties do run out.■

Richard F. Gillette (311 W. Daniels Rd., Palatine, IL 60067) is an engineering manager with Northrop Corporation's Defense Systems Division. He holds both a B.S.E.E. in communications and an M.B.A. in operations research.

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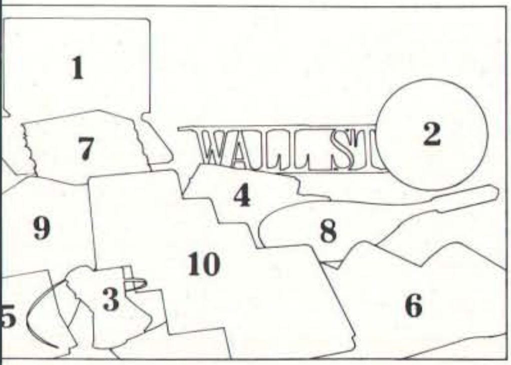

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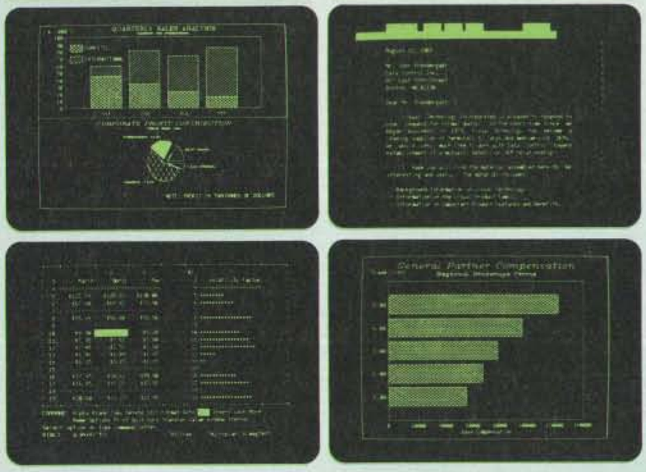

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Communications Software	**STANDARD**	$100-$200	$100-$200	$100	STANDARD
COMPLETE SOLUTION PRICE	**$2,695**	**$3,928-$4,628**	**$3,465-$4,165**	**$5,496**	**$4,940-$5,540**
Dual Drive Capacity	**800 KB**	640 KB	280 KB	2.5 MB	800 KB
Graphics Resolution	**640 x 300**	640 x 200	280 x 192	640 x 240	800 x 240
Keys on Keyboard	**93**	83	63	82	105
Expandable Memory	**YES**	YES	YES	YES	YES
Optional Winchester	**YES**	YES	YES	YES	YES
Tilt and Swivel Display	**YES**	NO	NO	NO	NO

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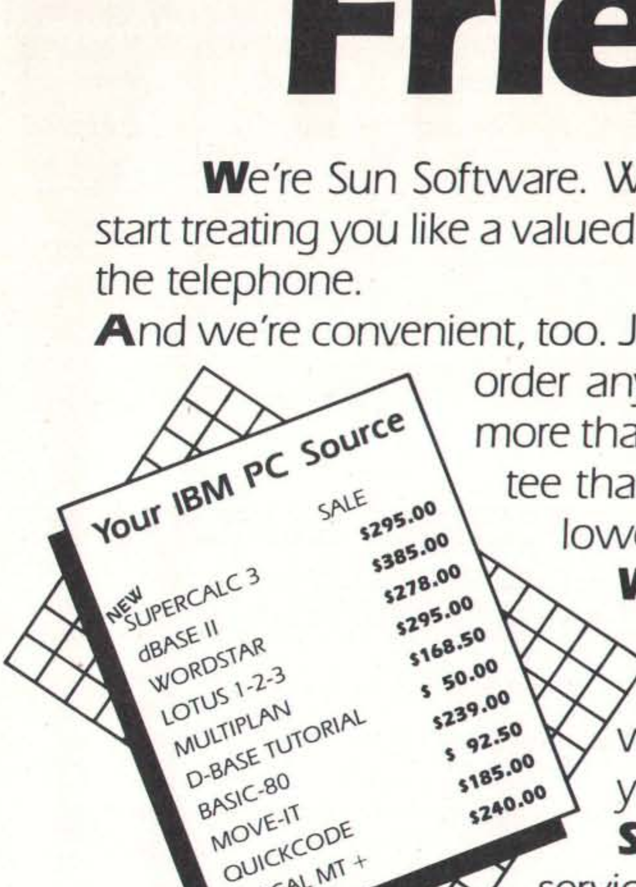

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The Einstein Compiler

This Applesoft BASIC compiler also serves as a helpful programming tool

by Peter Callamaras

The Einstein compiler, one of several BASIC compilers for Apple computers, is both easy to use and effective. Although other compilers claim they can provide compiled programs that run 2 to 20 times faster than their Applesoft BASIC counterparts, they cannot reveal what they're doing during compilation, nor can they do anything other than compile programs.

The Einstein, however, is not only a BASIC compiler: it's a useful programming tool as well. It provides a great deal of statistical information about the programs it compiles, and, when you enable the line-trace mode, you can also use it to debug a program.

The major task of a BASIC compiler is to convert a program written in BASIC into an equivalent assembly-language program. Much of the conversion performed by Applesoft compilers is based on a series of calls to routines in the Apple's monitor. By eliminating the need to interpret each line of program code, the compilation reduces program execution time.

At a Glance

Name
The Einstein compiler

Type
Applesoft BASIC compiler

Manufacturer
The Einstein Corporation
11340 W. Olympic Blvd.
Los Angeles, CA 90064
(213) 477-4539

Price
$119

Computer
Apple II/II Plus/IIe 48K bytes
Apple III in emulation mode
One 5¼-inch disk drive

Format
5¼-inch DOS 3.3 disk
Free backup disk upon return of warranty card

Audience
Novice or experienced Applesoft programmers interested in speeding up BASIC programs

Size vs. Speed

Although compilation speeds program execution, it also increases the size of the original program. The Einstein compiler, however, uses a code-compression technique to limit this increase; nevertheless, its compiled versions may be twice as long as the BASIC programs it began with. If the program is very large or made up of a series of modules, then the modules can be compiled and chained as a set of integrated modules. Modular programs are useful if you wish to later enhance certain parts of the program: you need only compile new modules to replace the ones you want to change. The manual explains this feature well.

The code-compression feature can be disabled, but program size will then increase dramatically in some cases. In one workout I gave the compiler, the original program took 5 sectors, the compressed compiled program filled 12, and the uncompressed compiled version 20. I prefer to use the compressed version.

Many manufacturers claim that their compilers provide twentyfold speed increases, but you can reasonably expect a compiled program to run about five to six times faster than the original BASIC program. I realized an approximate fourfold increase in execution speed each time I used the Einstein compiler. To make your own comparison, load a program on a cassette tape into the computer and then load the same program from a disk. The difference in the time you saved using a disk drive is about the same as the time you'll save running a compiled version of your BASIC program.

Number of Primes Used	BASIC Program's Execution Time (seconds)	Compiled Program's Execution Time (seconds)
55	63.95	11.21
1006	132.7	28.07
1437	210.09	42.91

Table 1: *This data compares execution times for an Applesoft BASIC program with a version compiled with the Einstein compiler. Data collected from three tests using the Sieve of Eratosthenes benchmark prime-number program show that the compiled program runs about five times faster than the original.*

Ease of Use

To compile your first program, simply

1. Load the BASIC program into memory.
2. Insert and run the Einstein program.
3. Press "Y" (for yes) to accept the standard Einstein parameters.
4. Save the compiled program.

That's all there is to it. The compiled program can be listed, but you will see only one line of code: 1 Call 4864. This line will start the compiled program running.

To test the time savings and size differences between BASIC programs and their compiled versions, I first ran a program I use to predict winners in professional football games. I have always been frustrated by the length of time it takes the program to determine the point spread and predict a winner when the program already has information from the preceding four or five games on which to base a decision. I selected six teams and had the program predict winners of the three games.

A BASIC program averages 23 seconds to figure a winner and point spread. The compiled version of that program (the compilation took about 65 seconds) calculated the point spread and predicted the winner in 5.3 seconds. For calculations on 28 teams (14 games), the waiting time decreased from 322 to 74.2 seconds—a 77 percent time savings.

The second test I ran was based on the Sieve of Eratosthenes benchmark prime-number program (featured in January 1983 BYTE, page 283). I decided not to run the full 8192 prime numbers and instead ran three tests: one with 55 prime numbers, another with 1006, and a third with 1437. The time savings, shown in table 1, were substantial. The execution rate of the compiled version was about five to six times faster than that of the original. The program did, however, expand from 3 sectors in the original to 15 sectors in the compiled version.

Compiler Components

The Einstein compiler disk contains three separate binary programs. The first is the Einstein program itself, which compiles the programs. The second program, Remark Remover, is a utility program used to remove remarks from the BASIC program before it's compiled. Because a program is converted from Applesoft into assembly language, the compiled program does not need the extra code required by the Remark statements. The third program, Remake Compiler Disk, is a special utility used to reconstruct the Einstein compiler should it be "blown up" through a destructive error. You can "destroy" the compiler by accidentally putting a write-protect tab on its disk and then attempting to use it, or by pressing the Reset key while the compiler is running.

If you damage the disk, contact the manufacturer for a replacement. When you send in the 90-day-warranty registration card, Einstein Corporation will send you a free backup disk. The compiler disk is copy-protected, not write-protected, because it constantly reads and writes to itself while compiling a program.

While you are compiling a program, various statistics concerning the compilation process appear on the video display. The compilation is carried out in several phases. In the analysis phase, variables are analyzed and stored, and the syntax of the program is checked. If a syntax error is detected, you can ignore it and continue the compilation or you can stop immediately. The Einstein software will compile a program with syntax errors in it. When I tried an "incorrect" program, it compiled and ran until the syntax error was encountered. After the analysis, the program stops and asks whether you wish to use any particular parameters.

The program then proceeds to the next phase, where the variables are defined in a symbol table, which you can examine for information about the assembly-language program being created. Specifically, the symbol table provides the name of each variable function in the original program, truncated to two characters. You also get a one-character display of the variable type. Real numbers are represented with a blank, integers with a percent sign, and strings with a dollar sign. A defined function is displayed as an asterisk. The hexadecimal address of the first byte of each variable (or variable array) is also provided. Next to the address, the length of the array, or variable, is expressed in hexadecimal units. Three special notes include 17-byte For . . . Next loops, defined functions of 8 bytes, and fixed-length strings that are 1 byte greater than their specified size. Information on dimensioned arrays is also included.

The program then proceeds into the compression analysis phase and creates a set of compression optimization tables. The final phase handles code generation, where the compiled code is generated and stored on the compiler disk. While the program prints each line number as it is compiled, a running tally of the percentage of source code compiled is reported. (You can compare this data with the compiled information in the symbol table.) Any address reference problems are then resolved, and the full compilation statistics are displayed on the screen.

The compilation statistics include information on the amount of space occupied by the compiled program, the area used by any global variables, the local area used by local variables, and the area reserved for use by dynamic strings (called the string pool). Other displayed information details additional facets of the compiled program. The compiler also creates a run-time library to get the compiled program up and running. The library consists of a set of machine-language routines the program uses when it runs. The amount of space saved by using the compression feature is also indicated.

The last phase of the compilation is the resolution of relocation information, of interest mainly to experienced programmers.

Once the compilation is finished, the program resides in memory, ready for you to run immediately or to save on disk. (I always save a program before running it.) Be sure you give the compiled program a different name than that of the original source program (I add the suffix .com), because once you overwrite the original BASIC source code, it is lost unless you have a backup copy. Some restrictions apply if you use relocatable code (these are covered in the user's manual).

A set of available compiler parameters covers the assignment of the printer slot, string information, addresses for the program, strings, different variable types, line tracing, code compression, reserved memory, loops, display addresses, and pause on errors.

The printer-slot parameter allows you to get a hardcopy printout of the compilation information for later use. You can select the other parameters depending on the program you are compiling and/or your use of the compiler for debugging purposes, such as enabling the line-trace mode. The manual details each of the parameters.

You can place certain embedded compiler directives inside the compiled program. They are a series of special annotated Remark statements that are not removed from the source code as are normal Remark statements. For instance, you could use one of the special Remark statements to call an uncompiled subroutine from within the compiled program. Other directives are available for the advanced programmer; these are thoroughly explained in the manual.

The manual is well-written and packed with information. It will be of help to both the novice and experienced programmer. The manual has a table of contents, an index, and an error-message section. It covers each compiler feature in separate task-oriented chapters. A set of sample tables illustrates the use of the symbol table and a set of sample programs permits practice compiling.

Conclusion

The Einstein compiler is an excellent program for converting Applesoft BASIC programs into assembly-language equivalents. It is easy to use, requiring only three steps to compile a program (if the user does not take advantage of the special parameter settings available). This ease of use has prompted me to use this program to compile all my BASIC programs to obtain faster execution speeds.

The Einstein compiler is packed with features to support use by both experienced and novice programmers. The parameter settings, for example, should accommodate the needs of any programmer. In addition, a comprehensive set of compilation statistics provides details about the compiled program.

Programs compiled with the Einstein software exhibit speed increases five to six times over those of their Applesoft BASIC counterparts. The user's manual is well written. In fact, it would make a good model for documentation writers to follow.

This compiler can be useful for all owners of Apple computers, even those who don't do much programming. It can speed up their BASIC programs and it might even encourage them to start programming in BASIC. Thus, it gives users the best of both worlds, easy programming in BASIC combined with the speed that assembly language affords.■

Peter Callamaras, an officer of the Air Force, can be reached at AFCC/EPPB, Scott AFB, IL 62225. The recipient of degrees in computer technology and biological sciences, he recently received his master's degree in systems management. He has been interested in computers since 1966 and used to be the service department manager of a computer store.

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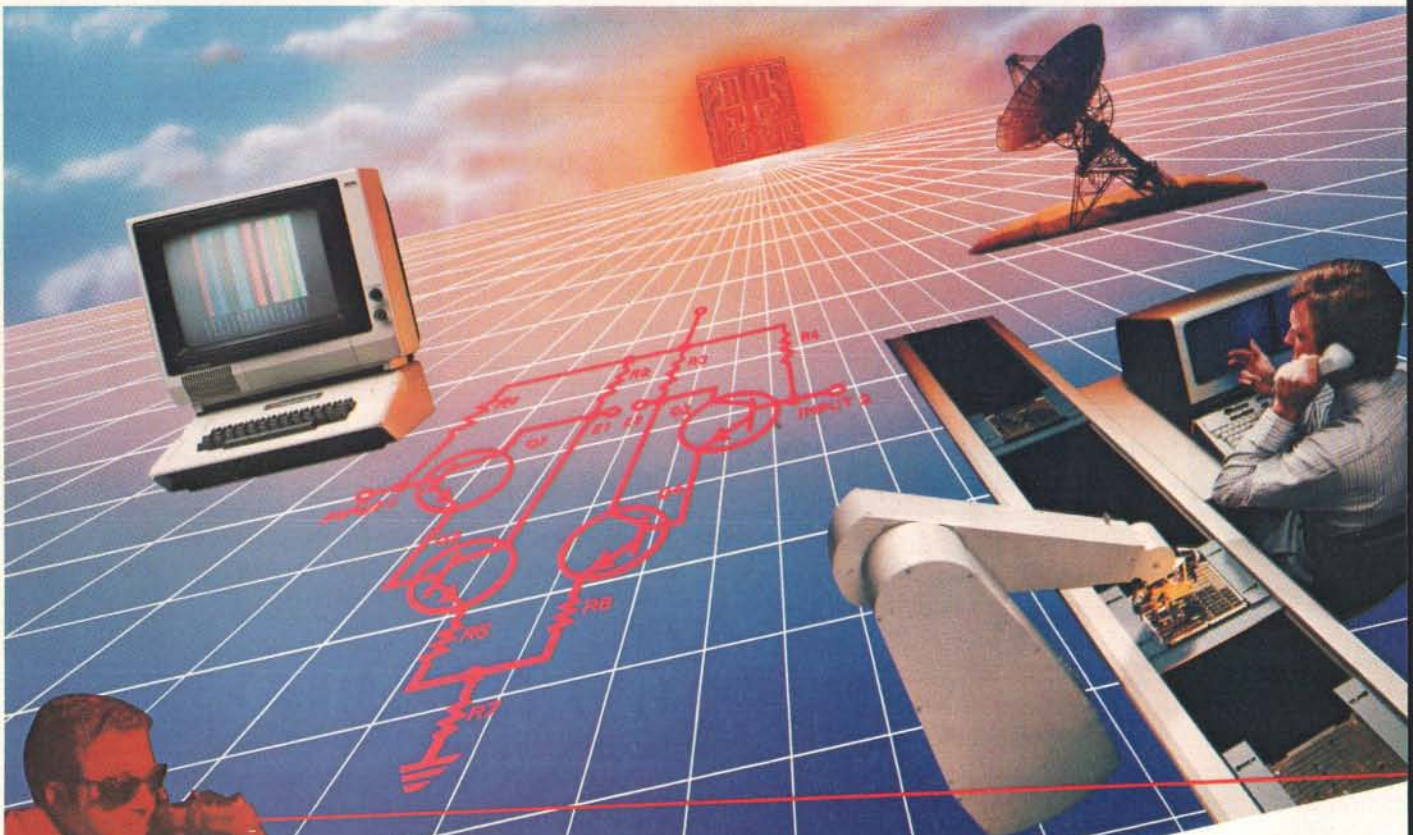

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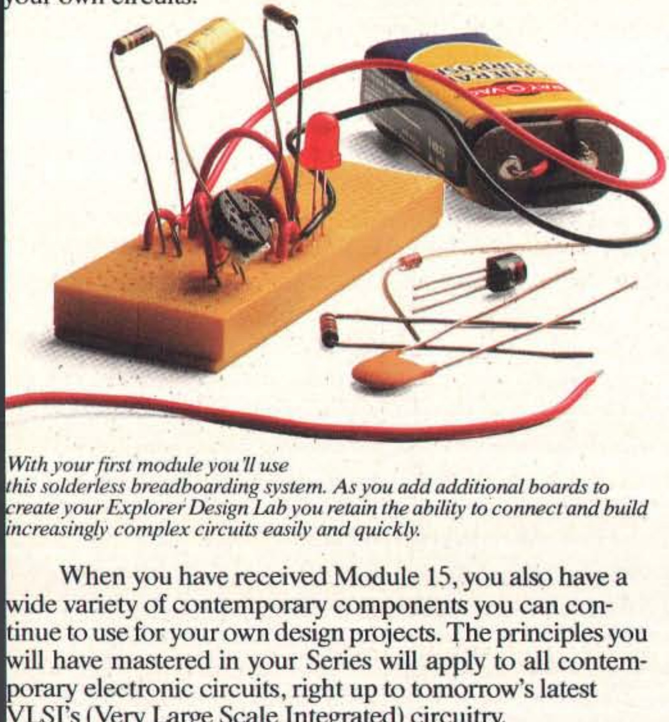

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Hardware Review

The Basis 108

A sleek import from Germany combines CP/M Plus with Apple compatibility

by Seth P. Bates

Flexibility, low cost, and abundance of software are the qualities that have made the Apple II a success. Now these qualities are available in a machine that comes already equipped with a variety of upgrades as standards. As well as providing complete compatibility with Apple II software and peripherals, the Basis 108 offers serial and parallel interfaces, 128K bytes of RAM (random-access read/write memory), an 80-column display, an RGB (red, green, blue) monitor interface, and a Z80 processor card. The Basis 108 was designed to meet the needs of professionals rather than hobbyists, but it is flexible enough for both.

Basis

Since 1979, Basis ("Bah-zis") Microcomputer GmbH. of West Germany has been the exclusive Apple distributor for Western Europe. The company produced keyboard encoders for upgrading the Apple II and helped establish requirements for the European version of the computer. In addition to the 108, Basis also produces two more sophisticated systems for business applications: the Basis 208 and 216.

In 1982, however, Apple began to market its own products in West Germany. On learning of Apple's plans in 1981, Basis decided to develop a proprietary, low-cost microcomputer that was both hardware- and software-compatible with the Apple II. The result was the Basis 108, which was introduced to the European market in January 1982. It was an immediate success. A short time later it was introduced in the United States by Basis Inc. of Scotts Valley, California. Last summer the distribution rights to the computer were bought by Computer Systems Designs of Ridgefield, Connecticut, which is now selling the Basis 108 at a much reduced price: $2595 for a complete system. It previously cost $3500.

The Basis 108 System

The 108 is structurally similar to the IBM Personal Computer (PC) (see photo 1), with a detached keyboard and two 5¼-inch disk drives. It has a 50-watt power supply (the Apple II has a 35-watt supply), a motherboard (photo 2), and mounting planes for two 5¼-inch drives. The back panel (photo 3) provides DB-25 sockets for serial and parallel I/O (input/output) and has cutouts for as many as six connectors. It also has RGB, black-and-white, and NTSC (National Television Standards Committee) video outputs; cassette I/O; a fuse socket; and power input. Two power outlets allow you to add a video display and printer that are switched on and off with the system.

The keyboard was designed to meet European ergonomic standards and is attached to the unit by a five-foot coiled cable. The keyboard has an 18-key numeric keypad, a 9-key cursor control block, and 15 programmable function keys (photo 1). The layout is similar to that of an IBM Selectric. The cursor block provides four standard cursor controls as well as Home, four Apple control-code keys (for clear-to-end-of-line and clear-to-end-of-page functions), and four directional codes. These keys allow single-keystroke cursor control in Apple software (standard in CP/M and Pascal), and they make a nice "bleep" when they are used.

Basis at one time offered a beautiful European-made, ergonomically designed high-resolution monitor with a 25-MHz bandwidth. This unit was quite expensive, however, and Basis discontinued it. I've found that the Electrohome 1302-2x monitor and Taxan's RGB Vision I monitor work well with the system, but the Electrohome cable needs a simple modification to work properly. The technical bulletin that explains this change is available from Basis. The latest word from the new distributor is that a monitor will now be bundled with the Basis 108 system.

The Motherboard

The Basis 108's motherboard (photo 2) is an economical design that has enabled Basis to manufacture it inexpensively, while offering standard features that would be costly to add to an Apple II. Both of the motherboard's microprocessors (a 6502 and a Z80) reside on the board, and both have direct access to the bus and address lines.

Apple Emulation

The 6502 mimics the operation of the Apple II processor, providing the same clock rate (1 MHz) and memory-mapping scheme. The monitor program for this processor resides in ROM (read-only memory) and fully supports both 40- and 80-column operation. The Z80 is dormant while the Basis is in 6502 mode.

At a Glance

Name
Basis 108

Manufacturer
Basis Microcomputer GmbH.
Muenster, West Germany

American distributor
Computer Systems Designs
99 Danbury Rd.
Ridgefield, CT 06877
(203) 431-4540

Standard system configuration
Basis 108 system unit with 128K bytes of RAM, two disk drives, monitor, keyboard, and power cables, CP/M Plus, Perfect Software packages, system disks, and operator's manual

Price
$2595

Processors
6502 (1 MHz) and Z80 (2 MHz)

Memory
128K bytes of RAM installed; sockets for 12K bytes ROM- or EPROM-based software

Features
Text and graphics options. Black-and-white, NTSC, and RBG video outputs. Game-control socket with 3 TTL inputs and 1 TTL output. Cassette, serial, and parallel interfaces. Six Apple II-compatible expansion slots. Detached keyboard with numeric keypad, 15 function keys, and a cursor-control block

Software included
CP/M Plus operating system; Perfect Writer, Perfect Calc, Perfect Filer, Perfect Speller; three disks of system utilities

Software options

Write Away word processor (by Midwest Software):	$175

Hardware options

256K-byte RAM pseudodisk board:	$695
Basis green-phosphor monitor:	$995

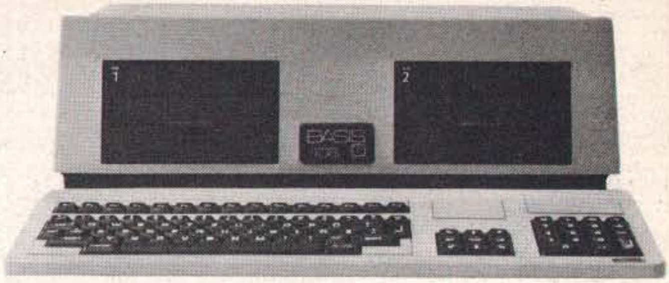

Photo 1: *The Basis ("Bah-zis") 108 is a microcomputer, configured like an Apple II, with Z80 and 6502 microprocessors and 128K bytes of RAM. The 108 comes with two Basis disk drives. The earlier model (shown here) has Micro-Sci drives. The keyboard provides all the features required of a business system.*

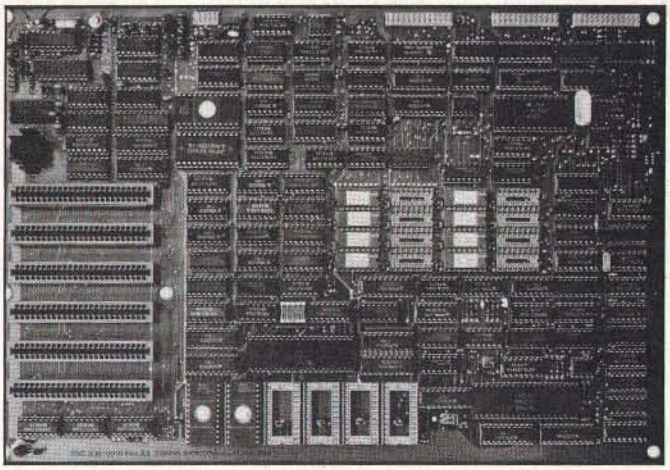

Photo 2: *The motherboard's expansion slots (similar to the Apple II's slots 2 through 7) are at the left. The character-set ROM chip is just above and to the right of the top expansion slot. Sockets for resident software in ROM are at bottom center, just below the Z80 processor. The 6502 chip is at right bottom, and the memory chips are just to the right of the center (shown here with only 64K bytes of memory).*

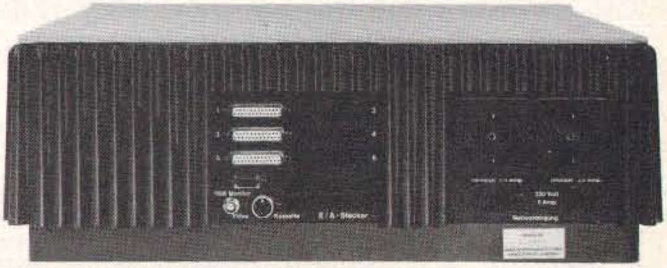

Photo 3: *The aluminum casting of the chassis is finned for strength at the rear. A cutout provided for a fan is not used (or needed). Six cutouts for DB-25 connectors are available, as are cassette, composite video, and RGB connectors. A flat-cable clamp can hold any loose wires and cables not using the connectors provided. Along with an easily accessible fuse, two switched outlets are provided in this European version. The U.S. version provides 110V outlets in their place.*

Basis Users Groups

N.Y. B.U.G.
William Cook, President
239 Demarest Ave.
Closter, NJ 07624
(203) 729-1600, ext. 286
(201) 767-0176

California Basis Users Group
Jim Fitch
35 National St.
POB 3068
Salinas, CA 93912

Table 1: *A list of users groups for the Basis 108. These users groups receive technical and customer-support mailings.*

Graphics modes

40 horizontal by 48 vertical	— 15 colors
80 by 48	— 15 colors
280 by 192	— 6 colors

Combined text/graphics modes

40 by 40 plus 4 lines of 40 characters
80 by 40 plus 4 lines of 80 characters
280 by 160 plus 4 lines of 40 characters
280 by 160 plus 4 lines of 80 characters

Table 2: *The graphics and text modes for the Basis 108.*

Hardware products tested

Apple Graphics Tablet
Echo II voice synthesizer
Grappler
Amlyn disk controller
Hayes Micromodem
Applecat modem
J-Cat 1200 bps modem

Table 3: *Apple peripherals found to be compatible with the Basis 108.*

Software products tested

Wordstar (Apple version for Videoterm 80-column card)
Apple Visicalc
Word Handler
Magic Window
Educational software from Spinneker Software and The Learning Company
Cfox and Aztec games

(Frogger and Pie Writer do not work with the Basis 108.)

Table 4: *Apple software found to be compatible with the Basis 108.*

CP/M

The Z80 has a clock rate of 2 MHz, the rate used by Microsoft's Softcard for the Apple II. It runs under a customized version of CP/M Plus (or CP/M 3.0), which is standard with the machine. This version of CP/M makes full use of the machine's 128K bytes of RAM by using a bank-selection technique. That is, small parts of the 128K memory are automatically switched into and out of the 64K memory space of the Z80. Fortunately, this procedure is user transparent.

This version of CP/M furnishes several other features, including three levels of file protection (password-based), three modes of automatic date and time stamping (a clock board is not required), and a 44K-byte print spooler. [**Editor's Note:** *According to Basis, two versions of CP/M Plus are offered. One has a printer spooler for the parallel port and a real-time clock. The other has a spooler for the serial port but no clock, because it handles the timing of the serial port. . . .* R.M.]

When running under CP/M, the Z80 uses the 6502 as a high-speed processor for I/O. The 6502 acts as an interface between the Z80 and the keyboard and the parallel and serial ports. When you start CP/M operation, the 6502 loads the operating system from disk and then passes control to the Z80. The Z80 then accesses memory directly but uses the 6502 for I/O functions.

Processor timing is critical in this system; the 6502 is a dynamic processor and would "lose itself" if it were not refreshed periodically. The Basis version of CP/M includes instructions to ensure that the Z80 controls the 6502's refresh process.

Text and Graphics

The Basis 108 provides four software-selectable character sets. They are programmed in a memory chip, a 2732 EPROM (erasable programmable read-only memory), which can be replaced or reconfigured by the user. In fact, Basis users groups (table 1) are developing some alternate character sets. The standard set includes the 64 Apple characters, the 128-character ASCII (American National Standard Code for Information Interchange) set, a full set of APL characters, and a special set of German characters. French, Spanish, Swedish, and Italian character sets are available from Basis in Europe.

The video-text-screen memory resides in static RAM chips, parallel to main memory, and is refreshed by high-speed interleaving. Video outputs are available for black-and-white, NTSC-color, and RGB monitors. The black-and-white mode provides a true gray scale for very professional-looking black-and-white graphics. Table 2 describes the various graphics and text modes.

Resident Software and RAM

In addition to the character sets in ROM, the Basis provides for up to 12K bytes of ROM-based software (or firmware). As mentioned above, the Basis 108 also comes with its own monitor program in ROM, which lets the user choose between a 40- or 80-column display. This selection may be made during initial system booting or any other time by pressing a certain key sequence. The owner's manual includes a complete listing of the monitor program code.

D B M S ?

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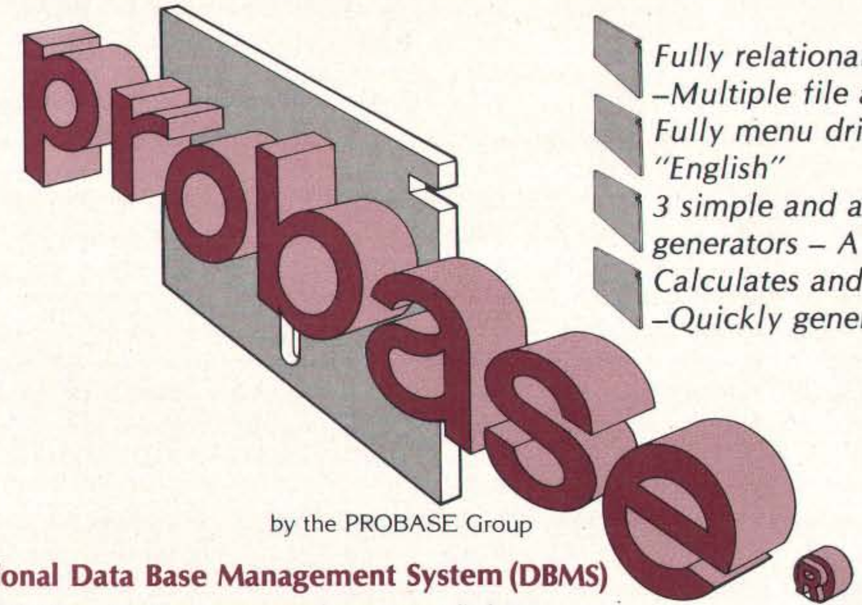

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The standard system comes with 128K bytes of RAM, which is handy because CP/M Plus takes up a sizable portion of the lower 64K bytes. Basis also offers a 256K-byte RAM-disk board for $695.

Bundled Software

The Basis 108 comes with a bundle of software from Perfect Software. This set includes Perfect Writer, Perfect Speller, Perfect Calc, and Perfect Filer.

Expansion Slots

The Basis 108 has six slots that accommodate Apple expansion boards. They are equivalent to slots 2 through 7 of the Apple II. Since the connections for these slots are supposed to be identical to the Apple's, the Basis 108 should be 100 percent compatible with Apple II boards. I tested these slots with several products (see table 3). Of course, any board that must go into slots that correspond to the Apple's 0 or 1 slots will not work; but since the Basis already has an extra 16K bytes of memory (which would go into slot 0) and a parallel printer port (slot 1 on the Apple II), this discrepancy in the number of slots should not be too much of a problem.

The system is configured to recognize the serial interface at logical slot 9. This interface provides two handshake circuits and transmission rates from 50 to 19.2K bps (bits per second). Several cards useful in an Apple II or IIe are not needed here because their functions are already provided. These cards include serial and parallel interfaces, a RAM card, and an 80-column uppercase/lowercase text-display card. The six remaining slots should meet the needs of most users.

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Optional Hardware and Disk Systems

Until the spring of 1983, the Basis 108 had been sold in versions with a choice of two disk drives, one, or none. It is now sold in only one version, which will provide two German-built Shugart-based disk drives offering 100 percent Apple compatibility and is controlled by a proprietary diagnostic controller card that automatically checks all system functions on power-up. This facility can be disabled or accessed at any time while the machine is on. The controller is built for Basis by Prometheus, which also developed the popular Appleshurance disk controller.

One slot of the 108 is taken up by this diagnostic disk controller, but since parallel and serial interfaces and a full 128K bytes of memory all reside on the motherboard, the five remaining slots are free for more exotic uses, such as modem cards and A/D (analog to digital) converters.

Eight-inch disk-drive controllers for the Apple will work with the 108, although such drives will not fit the 108's front-panel 5¼-inch cutouts. Basis uses 8-inch drives in its 208 and 216 models and might decide to offer an 8-inch modification kit for the 108 as an option.

Another interesting possibility would be to use two half-height 5¼-inch drives in one side of the 108 and a 5¼-inch hard disk in the other, thus providing a powerful, compact system. Davong, Xebec, and Corona hard-disk drives should all work with the 108, but since CP/M Plus is new, no manufacturer has yet written the BIOS to interface its hard-disk drive to this operating system. Apple users who own the Microsoft Softcard (and hence have the old CP/M version 2.2) can use the hard-disk drives immediately. The Amlyn 8-megabyte removable minipak drive works beautifully with the system and has been popular.

For those seeking 16-bit computing compatibility, Metamorphic's 8088 card for the Apple works without problems. It provides MS-DOS, the 16-bit UCSD P-system, and CP/M-86 compatibility. With this card, the Basis contains three separate and independent processors—a 6502, a Z80, and an 8088. It would also be compatible with seven of the current predominant operating systems—Apple DOS 3.3, Apple Pascal, CP/M, Turbodos, MS-DOS, CP/M-86, and 16-bit Pascal.

Software

Besides the CP/M Plus disk, the 108 comes with three disks of system utilities. One, The Filer from C.P. Software contains three excellent disk-management utilities, an operating system compatible with Apple DOS 3.3, and an Apple-compatible floating-point BASIC interpreter. Unfortunately, this operating system and BASIC interpreter cannot be used apart from these utilities. Pur-

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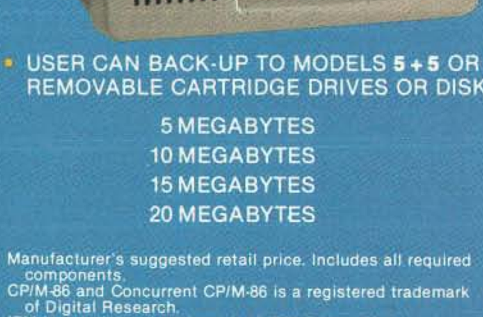

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chasers wishing to use Applesoft BASIC for programming must purchase the software on disk or in ROM chips. A ROM chip set is available from Computer Discount Products (860 South Winchester Blvd., San Jose, CA 95128) for about $125. The Apple UCSD Pascal can be purchased on disk as well, for about $230.

Another disk that is provided, the System Booter, can reconfigure a 40-column Apple BASIC interpreter to a 40/80-column selectable version for the Basis system. Most users, however, will want the dealer to take care of this reconfiguration because the booter runs only under Pascal. But if you own Pascal, you can do your own configuration.

The remaining disk is the Basis utility disk, which modifies the Apple UCSD Pascal operating system to recognize special features of the 108. Also, this utility will modify Apple DOS 3.3 to recognize the serial port at logical slot 9 and to allow the saving and retrieving of upper- and lowercase-text files.

Advanced users will probably want to turn their modified Applesoft BASIC interpreter into an EPROM chip set and thus end up with a system that strongly resembles an Apple II Plus.

A software deal that is offered by Basis is Perfect Software's CP/M-based products, including Perfect Writer, Perfect Speller, Perfect Filer, and Perfect Calc as a package with the 108 for $275. Basis users should stay in touch with the company (or dealers) because more software is being optimized for the systems.

Dealer Support

Basis is establishing a dealer network and is most interested in dealers who will provide full-service system support. The former distributor maintained a commitment to its dealers to provide parts replacements within 24 hours of a request.

Conclusions

The Basis 108 is a beautifully designed and constructed product that offers Apple II and CP/M compatibility in addition to features that both writers and businessmen need. Some users will be disappointed by the system's size and weight (it's a bit larger than an Apple II). But professionals and hobbyists will appreciate the quality of its construction, and both its structural and electronic design. The system is also ideal for school and university applications.

The quality of the video section is excellent, and the 40-character Apple-like screen is stunning. The chassis cutouts allow the disk drives to be installed inside, resulting in a clean, attractive appearance. The detached keyboard, in addition to being well thought out, is a major improvement on any Apple II upgrade. The Basis 108 may indeed provide more built-in flexibility than any other computer on the market.■

Seth Bates (Division of Technology, San Jose State University San Jose, CA 95014) is a doctor of industrial technology. His interests include programming, trout fishing, and reading science fiction.

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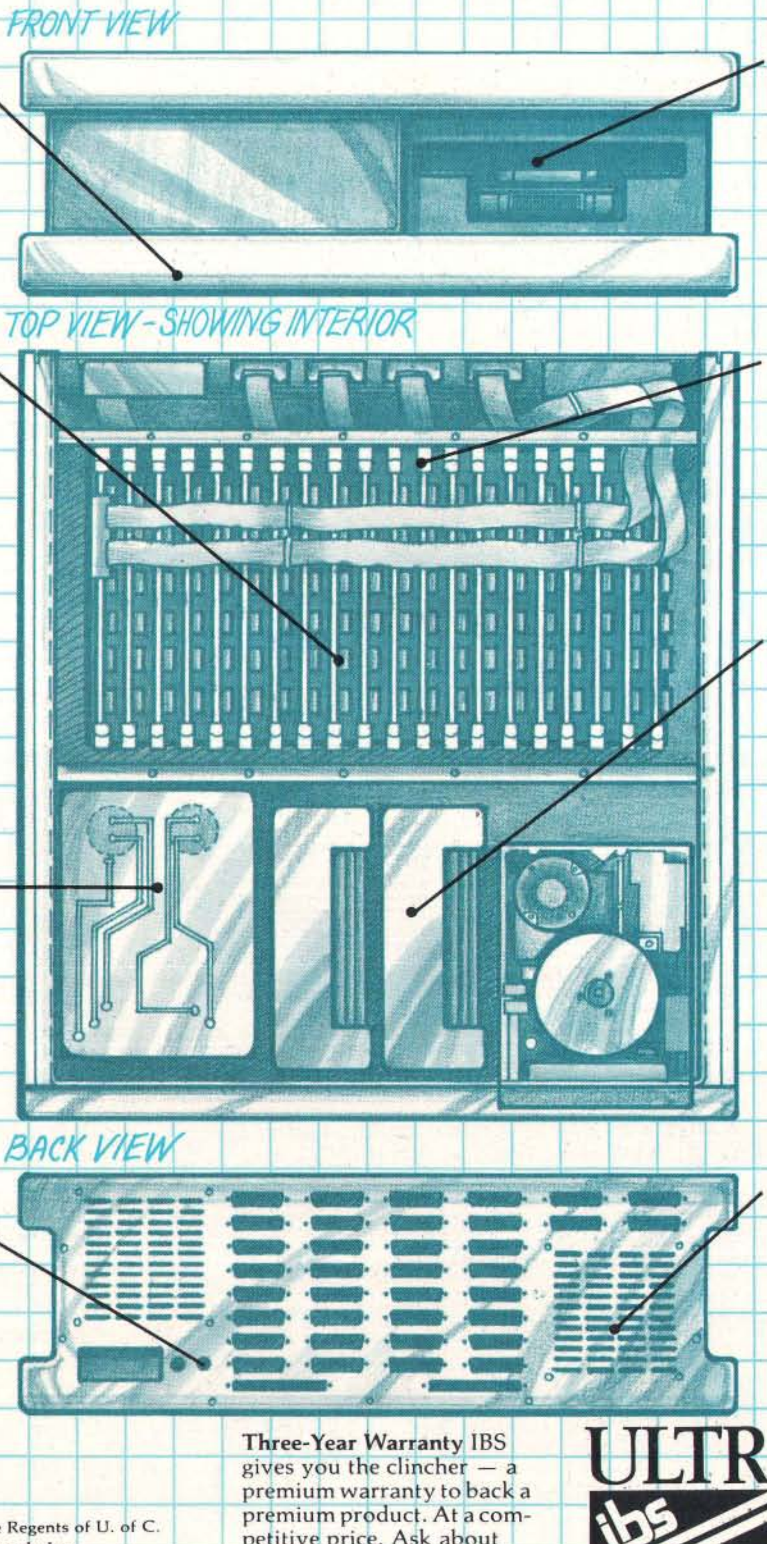

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Bubbles on the S-100 Bus

Part 1: The Hardware

Build a fast-access 128K-byte bubble-memory board for your S-100 system

by Louis Wheeler

Before beginning work on this article, I checked back issues of BYTE for any previous articles on the subject of bubble memories. It was a short list—the loneliest number of all. A. I. Halsema's "Bubble Memories: A Short Tutorial" (June 1979, page 166) contains a lot of good information on how bubble memories work.

There was an earlier mention of bubble memory in BYTE. The July 1977 issue contained an editorial by Carl Helmers, entitled "This Elephant Never Forgets." In it he discussed the then-new Texas Instruments TBM0103 bubble-memory chip. The editorial wound up by calling for some "technologically enterprising reader" to "purchase the early sample versions of the bubble memory chips along with documentation, and design a homebrew computer interface which we can publish for the benefit of all BYTE readers." Apparently, no one ever answered the call. Perhaps that early version was either too expensive or the circuit requirements too complicated. Anyway, here's (perhaps) the article he requested.

Photo 1: *The Intel Magnetics Inc. BPK 72 Bubble-Memory Prototype Kit comes complete with a 4- by 4-inch PC board, all components, and extensive documentation. A simple interface and some software are all you need to build an S-100 disk emulator.*

In part 1 I'll provide some basic information on bubble memory in general. Using Intel's BPK 72 Bubble-Memory Prototype Kit (see photo 1), I'll show you how to build a 128K-byte bubble-memory board for your S-100-bus system. Part 2 will cover the software testing and modifications necessary to realize the potential of the bubble-memory system. The completed project will function as either a floppy-disk replacement (or augmentation) or a cache memory.

Since the 1979 article and 1977 editorial were written, Texas Instruments has dropped out of the bubble-memory business. However, in 1979 Intel introduced its first bubble-memory system and, fortunately, has kept the concept alive. The Intel Magnetics Inc. version, the 7110 Megabit Bubble Memory, stores 1,048,576 bits (128K bytes) of data and has a transfer rate of 100,000 bits per

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second (bps). That's a lot of data to store in one small component. It has more than 10 times the capacity and twice the speed of the earlier TI bubble memory. Although bubble memories have been slow in coming for a number of reasons, including difficulties in fabrication and the cost of manufacture, it appears that they have finally arrived.

What Will It Cost?

Recently, several ads for disk-emulator, disk-simulator, and cache-memory systems have appeared in computer magazines. The prices of these systems range from $900 to several thousand dollars. Since March of 1983, I have seen two ads for bubble-memory boards: one for the Apple and one for S-100 systems. The Apple board, Bubdisk, from MPC Peripherals, lists at $875 and was reviewed in the July 1983 BYTE on page 226. When I called the company advertising the S-100 board, I was informed that lack of interest in the board had caused the company to discontinue marketing it.

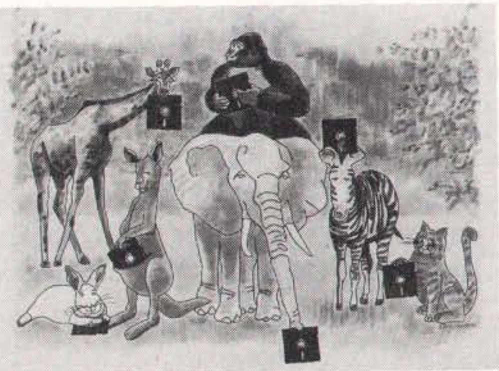
How do these prices compare with this project? The latest price I have for the Intel BPK 72 Bubble-Memory Prototype Kit is $550. The S-100 prototype board and other components will cost about $50. The approximate total cost of $600 compares favorably with the disk emulators and bubble-memory boards now available.

The bubble-memory board is piggybacked onto the S-100 wire-wrap board.

Inside the Bubble

Bubble-memory technology is a highly compact, reliable, nonvolatile storage medium. It is more properly called magnetic-bubble memory because it stores data in the form of movable magnetic domains on a thin film of magnetic material divided into tiny magnets. The word "bubble" comes from the fact that viewed under a microscope these magnetic domains resemble tiny bubbles (Don Ho, take note). The bubbles are moved about under the influence of an external rotating magnetic field. The small internal magnets themselves do not rotate, only the magnetic field, which is created by phasing currents through two coils surrounding the film of magnetic material. This nonmechanical aspect of bubble memory is what makes it so reliable when compared to other high-capacity storage media such as the floppy disk.

For many applications, bubble memories afford a number of advantages over both floppy disks and cache memories. Bubble memories are two to four times faster than floppy-disk drives. They are also many times more reliable because there are no heads to load and move or disks to turn and, therefore, nothing to wear out. A bubble-memory system's compactness lets it easily fit inside a computer enclosure without the usual boxes and cables that can clutter up your desk. Both floppy disks and bubble memories



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5¼" SSDD Soft Sector w/Hub Ring	M13A	1.79	51401	1.89	5SSDD-RH	1.94	3481	1.94	MFD-11	2.09	801187	3.19
5¼" SSDD Same as above, but bulk product	M13AB	1.59	00096	1.59	—	—	—	—	—	—	—	—
5¼" SSDD Soft Sector Flippy (use both sides)	M18A	2.69	—	—	—	—	—	—	—	—	—	—
5¼" SSDD 10 Hard Sector w/Hub Ring	M43A	1.79	51410	1.89	5SSDD-10RH	1.94	—	—	MFD-12	2.09	801014	3.19
5¼" SSDD 16 Hard Sector w/Hub Ring	M53A	1.79	51416	1.89	5SSDD-16RH	1.94	—	—	MFD-13	2.09	801188	3.19
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5¼" SSDD Soft Sector w/Hub Ring (96 TPI)	M15A	2.59	51801	2.59	5SSDD-96RH	2.79	—	—	MFD-20	2.94	800439	3.89
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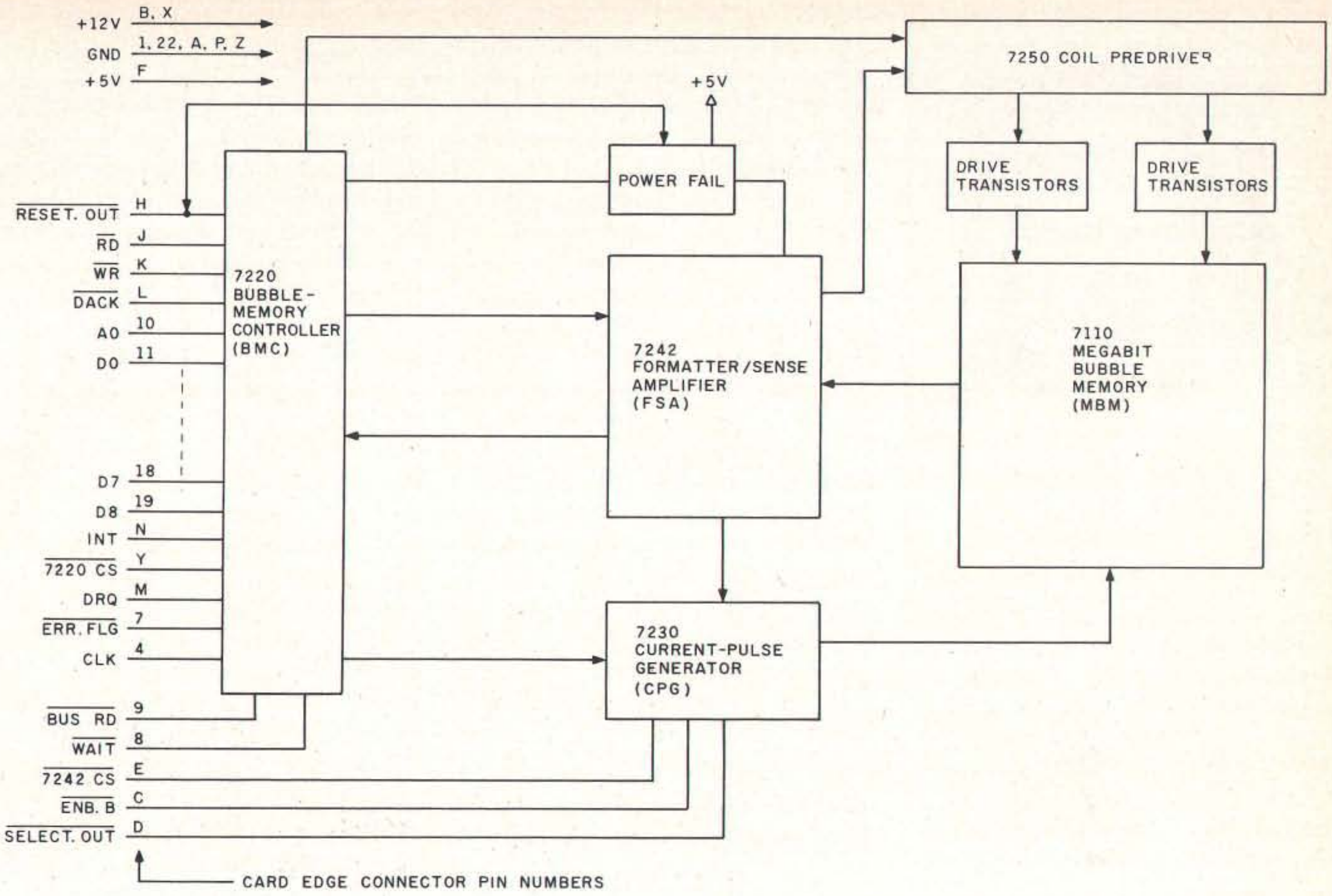


Figure 1: *A block diagram of the BPK 72 Bubble-Memory Prototype Kit.*

offer nonvolatile storage, which isn't true with most of the cache-memory systems now on the market. Because cache-memory systems use standard RAM (random-access read/write memory) chips, when the power fails, the data is lost. To overcome this problem, some cache-memory systems rely on bulky batteries that suffer the need for periodic replacement. Of course, all three storage systems have advantages; a library of bubble memories is still too expensive for most of us, and although they are fast, nothing is faster than RAM.

If you want to know more, obtain a copy of *A Primer on Magnetic Bubble Memory* from Intel, which is well worth reading. And even if you do not yet thoroughly understand bubble memory, don't let that stop you from enjoying this project. After all, learning is a major part of what building it yourself is all about.

The Bubble-Memory Kit

Bubble-memory chips and the required support circuitry are quite complex. Not only are they complex, but sensitive, low-level signals and stringent layout requirements probably preclude the use of wire-wrap techniques. However, thanks to Intel, the BPK 72 Bubble-Memory Prototype Kit solves most of these design and construction problems. A word of caution, though: this is not a Heathkit-type kit. Rather, it is an evaluation kit intended for engineers. Therefore, the user's manual is heavy on theory and light on assembly instructions.

Intel Magnetics' prototyping kit includes ICs, resistors, capacitors, test hardware, and documentation.

The kit comes complete with a PC (printed-circuit) board, all resistors and capacitors, a test module, a subassembly to "reseed" the bubble memory (should this be necessary), and lots of documentation. Figure 1 is a block diagram of the complete BPK 72 circuit. It lacks only an interface, clock, and power supply. Adding these three items is not very difficult, as you will see. The completed bubble-memory system illustrated in photo 2 is made up of the following active components: a single 128K-byte 7110 MBM (Megabit Bubble Memory), one transistor, and seven ICs (integrated circuits): one 7220 BMC (Bubble-Memory Controller), one 7250 Coil Predriver, two 7254 Quad Drive Transistor Packs, one 7230 Current-Pulse Generator, one 7242 FSA (Formatter/Sense Amplifier), and one IN75463 OR gate.

The extensive documentation accompanying the kit details the operation of the 7110 MBM and the function of each support component. Much of the documentation is oriented toward the design of a complete bubble-memory system, including PC-board layout. However, because this project treats the BPK 72

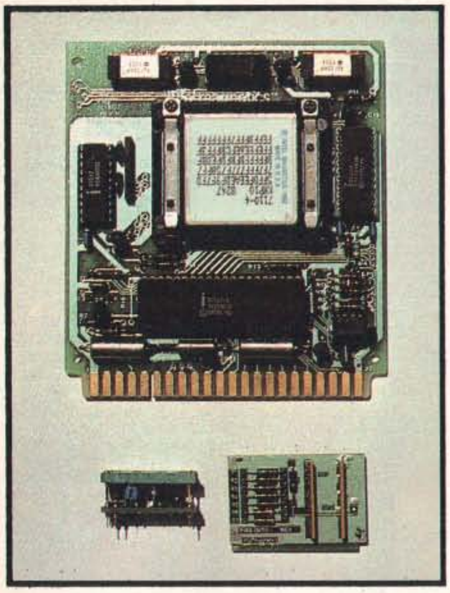


Photo 2: *The assembled BPK 72 with the 7110 Megabit Bubble Memory installed. The seed module (bottom left) is used to restore missing seed bubbles. The dummy module (bottom right), an electrical equivalent of the bubble-memory chip, is used for tests.*

kit as though it were a single component, we are primarily concerned with only the 7110 MBM and the 7220 BMC.

For the sake of completeness, the following is a brief description of how it works. The subject is covered thoroughly in the documentation accompanying the kit. Refer to figure 1.

Data flowing in and out of the bubble memory passes through the 7242 FSA. Two channels connect the FSA with the 7110 bubble memory (actually, the bubble memory is divided into two sections). The FSA amplifies the weak signals from the bubble memory and also masks out the defective or unused (spare) data loops according to the bit pattern stored in the *boot-loop* registers. Although 320 data loops are available, only 272 are actually used. The extra loops provide a greater production yield during the manufacturing process. This is a common practice in the manufacture of memory components. (Normally, users are usually unaware of it, and this is of little or no concern. However, this is not so with bubble memories, for even though the selection process is done at the factory and recorded in the bubble memory, we have access to the boot-loop mask and can change it if necessary.) The FSA also performs automatic error detection and correction, a user-selected option that eliminates the need for things such as software checksums.

From the FSA, the data is fed into a FIFO (first-in/first-out) buffer in the BMC. The FIFO buffer holds up to 40 bytes of data. Its primary purpose is to alleviate timing differences among the user interface, the BMC, and the FSA. All communication with the bubble memory occurs through the BMC, which is addressed as two I/O (input/output) ports. One port (hexadecimal E1 in the schematic and software listings) is for command and status, and the other (E0) is for data transfer to/from the FIFO buffer. The command port has two functions: one to initiate BMC functions such as READ and WRITE and the other to set up a starting address to one of six parametric registers.

I had no difficulty completing the assembly after studying the schematic and parts list.

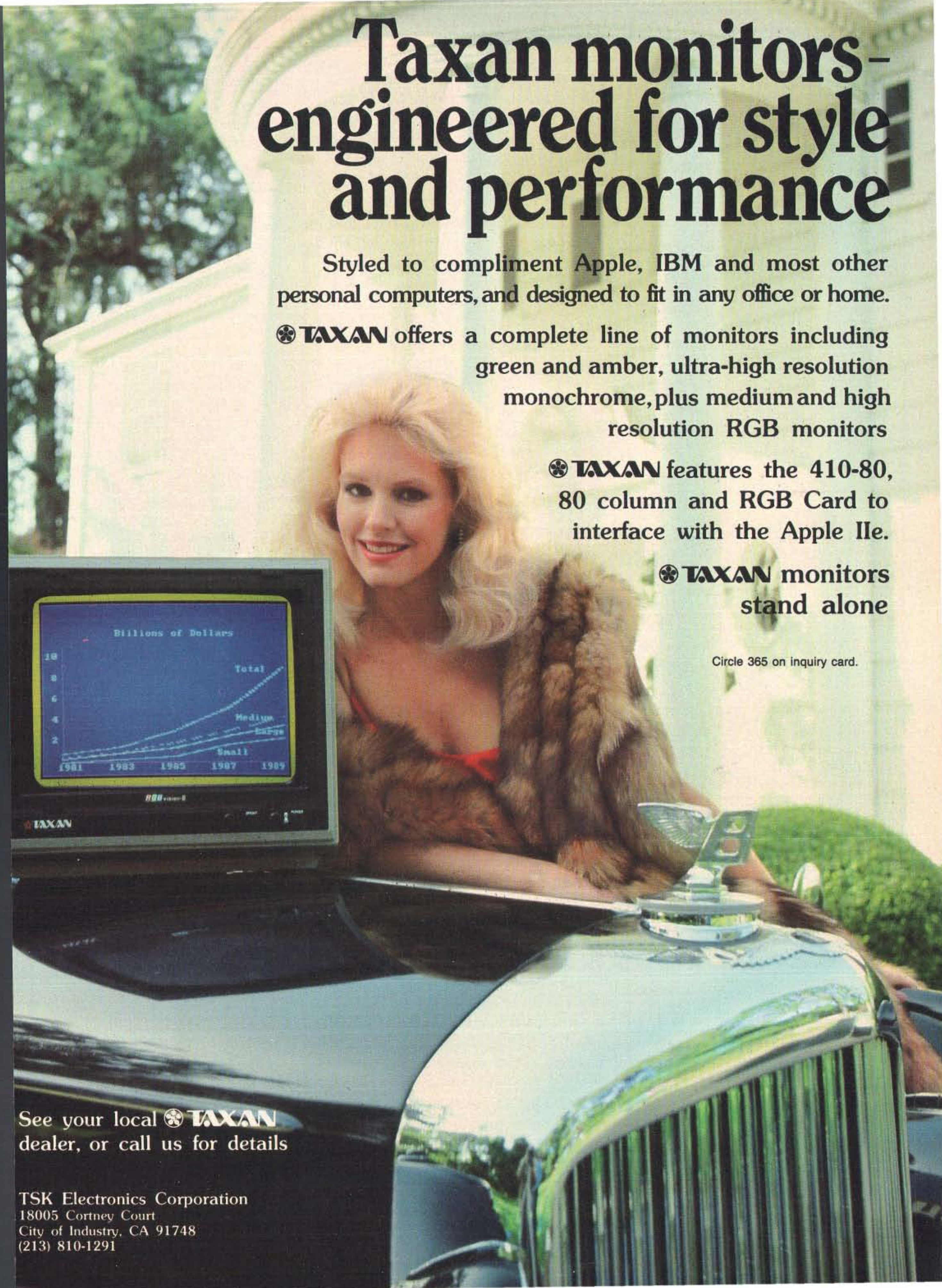
The parametric registers are akin to a disk's parameter block. They determine the number of FSA channels to be used and block length (pages of 64 bytes to be transferred); enable automatic error correction, DMA (direct memory access) operation (requires DMA controller), interrupt conditions, and data-transfer rate read); and select which bubble-memory chip to address in multibank systems and the starting page (64-byte record) address within the selected bubble memory. The setting up of the parametric registers is accomplished in the SNDREG subroutine in the driver package to be discussed in part 2. Normally, bubble-memory read/write operations proceed as follows. The parametric registers are set up with the required information, then the desired function (READ, WRITE, etc.) is selected by sending a BMC command. When the status indicates that the FIFO buffer is ready to receive data or has data waiting, data is then transferred to/from the FIFO buffer.

Although I read all the literature very carefully, I still found it difficult to picture what is actually going on in the bubble memory. With 272 data loops, boot loops, seeds, input tracks, output tracks, and a lot more, it all became a bit confusing. I thus simplified things by looking at it this way: the 7110 chip has a capacity of 1,048,576 bits. Changing bits to bytes, the storage capacity is exactly 131,072 bytes (usually expressed as 128K bytes). The smallest block of data that can be accessed (read/written) is 64 bytes, so what we really have is a device that can store 2048 (64-byte) physical records (Intel uses the word "page"). However, it is possible to extend the block size in multiples of 64 bytes, allowing us to effectively have records ranging from 128 bytes to 131,072 bytes. Therefore, for systems employing a physical-record size of 128 bytes (e.g., CP/M), the block size is two, with a total of 1024 records. For systems with a physical-record size of 256 bytes, the block size is four, and the number of records is correspondingly reduced to 512.

Assembling the BPK 72 Kit

Because the BPK 72 kit is intended for engineers, so, too, is the documentation. A fair knowledge of digital electronics and some previous experience in electronic kit building would be useful, as assembly instructions are almost nonexistent. Basically, the manual says that this kit includes a printed-circuit board on which the components supplied are to be mounted. Assemble the board, referring to the assembly drawing, schematic, and parts list. Attach a suitable user interface as detailed in another section. And that's it. Although the *BPK 72 Bubble Memory Prototype Kit User's Manual* contains about 40 pages, a single paragraph covers actual assembly. The remainder of the manual is taken up with interface requirements, operating information, support components, and service information.

However, the PC board is small, 4 by 4 inches, with only eight ICs, one



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transistor, and a few other components, and I had no difficulty completing the assembly after studying the schematic and parts list. If you have assembled one of the larger Heathkit kits, you should have no difficulty in assembling this small PC board. The only tools required are a low-wattage soldering iron, side cutters, a small Phillips screwdriver, and a magnifying glass to inspect for solder bridges. An ohmmeter and a 10-MHz, or higher, oscilloscope will be needed for the preliminary testing discussed later.

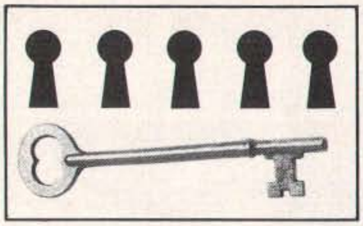
I suggest assembling the kit as follows:

1. Locate and mount all the IC sockets. The 7110 bubble-memory socket must be oriented with the two Phillips-head screws on the side of the card opposite the edge-connector pins (toward the top in photo 2).
2. Install the transistor.
3. Install all the resistors and diodes. The locations are marked on the PC board, and the values are indicated on the schematic and parts list.
4. Similarly, install all the capacitors.
5. To complete the assembly, install all the ICs *except* the 7110 bubble-memory element itself; install the dummy module instead. Preliminary testing requires this dummy module.

The S-100 Interface

Before we can test the bubble-memory system, we will need an interface, a clock, and a power supply. The interface requirements of the kit are such that we can look at it as though it were a single component. The 44-pin edge connector, the P1 block in the schematic (figure 2), then represents the bubble memory and all the associated support circuitry. The rest of the process is really quite simple. The address-decoder circuit (ICs 2 and 4) consists of two 8205 (74LS138) 3- to 8-line decoders. As wired, the port addresses are hexadecimal E0 and E1; however, this can easily be changed by selecting other output pins on one or both of the decoder ICs. ICs 8 and 9 split the

MAKING THE TOUGH DECISIONS



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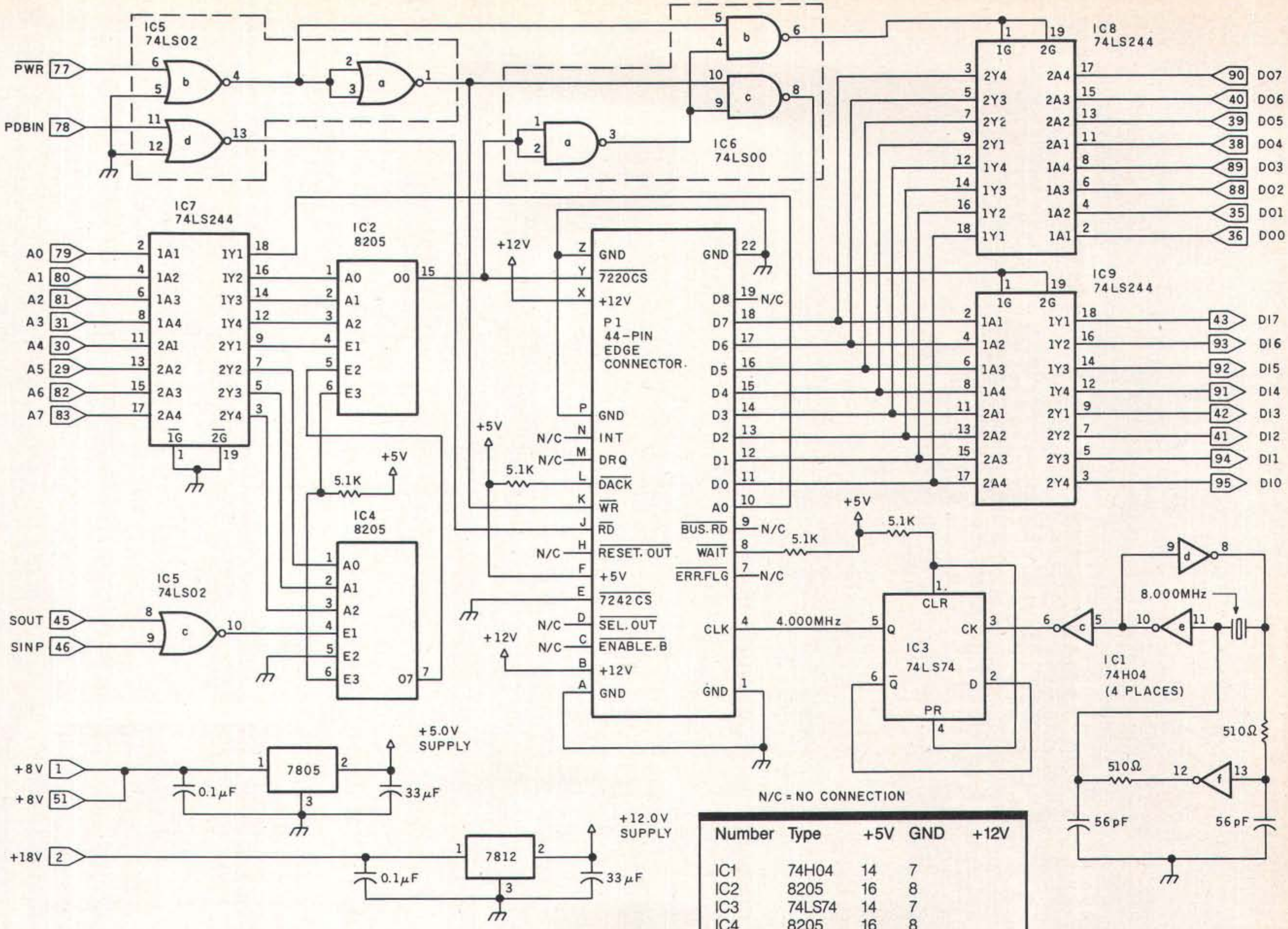

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Number	Type	+5V	GND	+12V
IC1	74H04	14	7	
IC2	8205	16	8	
IC3	74LS74	14	7	
IC4	8205	16	8	
IC5	74LS02	14	7	
IC6	74LS00	14	7	
IC7	74LS244	20	10	
IC8	74LS244	20	10	
IC9	74LS244	20	10	
P1	BPK 72	F	1,22,A, P,Z	B,X

Figure 2: *A schematic of an S-100 interface and clock circuit for the BPK 72. The kit is used as though it were a single component. Only the edge connector is shown in this figure. The schematic placement of the edge-connector pins matches that of the actual physical component. The completed project functions as either a disk emulator or a cache memory system.*

multiplexed data bus into separate input and output buses according to S-100 conventions.

The 4-MHz clock circuit, ICs 1 and 3 (oscillator/divider, respectively), is the circuit suggested in the application note supplied with the kit. It should be constructed with care, keeping the leads as short as possible. Note that the crystal is an 8-MHz series-resonant type, 0.1 percent tolerance, and should be a high-quality component. The clock frequency must be stable and within the narrow range of 3.996 to 4.004 MHz to assure that the bubble-memory rotational-field specification is met. This is more stringent than many digital-circuit clocks. The application note also calls for the use of a 74H04 inverter (IC1). Unable to obtain a 74H04, I tried a 74LS04, which *did not* work and resulted in a large number of read/write errors, plus an occasional timing error. However, when I substituted a 7404, everything worked well.

Several signals appearing on the BPK 72 edge connector (table 1) are not used in this project. Some of these signals, $\overline{\text{7242 CS}}$ for example, are intended for use in systems employing more than one 7110 bubble memory. Others are intended for special applications. Two of these, $\overline{\text{DACK}}$ and DRQ, are for use in systems employing DMA. In small single-user systems such as mine, there is little or no advantage to using DMA (considering the added cost and complexity). If, on the other hand, you want to use the bubble memory for real-time data acquisition, DMA would become a necessity. As for interrupts, floppy-disk operating systems generally disable interrupts during disk-access operations. Therefore, no provision has been made for them. The software presented here also disables interrupts during read/write operations. If you want to use the interrupt system, it will be necessary to add an open-collector-type inverter, such as a 74LS05, connected between pin N of the edge connector and one of the S-100-bus interrupt lines.

It might appear that the $\overline{\text{RESET.OUT}}$ signal, pin H, should be

Pin Number	Signal Name	Description
1	GND	Ground (one of five).
2	—	Not used.
3	—	Not used.
4	CLK	Clock input for BMC and FSAs. Frequency should be 4.000 MHz +/− 0.1 percent with a duty cycle of 50 percent +/− 1 percent to assure that the bubble-memory rotational-field specifications are met.
5	—	Not used.
6	—	Not used.
7	$\overline{\text{ERR.FLG}}$	A signal generated by the FSA to inform the BMC of an error condition. Used in multibank systems.
8	$\overline{\text{WAIT}}$	A bidirectional signal used in systems with multiple BMCs, allowing them to inform each other of an error condition.
9	$\overline{\text{BUS.RD}}$	Input/output mode signal used between BMC and FSA.
10	A0	An address bit that selects which BMC register is involved. If A0 is a "1," the command, status, or register address counter is selected. If A0 is a "0," the parametric registers are being addressed.
11	D0	Bidirectional data bus carrying data between the user's system and the BMC.
12	D1	Data bus.
13	D2	Data bus.
14	D3	Data bus.
15	D4	Data bus.
16	D5	Data bus.
17	D6	Data bus.
18	D7	Data bus.
19	D8	Parity bit for the data bus. The BMC checks D8 for odd parity coming from the user's system and generates odd parity for data transferred from the bubble memory.
20	—	Not used.
21	—	Not used.
22	GND	Ground.
A	GND	Ground.
B	+12V	+12-volt supply (one of two).
C	$\overline{\text{ENABLE.B}}$	The same as $\overline{\text{ENABLE.A}}$, a signal used to select the 7230 Current-Pulse Generator and the 7250 Coil Predriver. Not used.
D	$\overline{\text{SELECT.OUT}}$	Used in multibank systems to select the next 7240 FSA in the FSA daisy chain.
E	$\overline{\text{7242 CS}}$	Used in multibank systems as the chip-select signal for FSA bank select. In single-bank systems, it should be tied low.
F	+5V	+5-volt supply.
H	$\overline{\text{RESET.OUT}}$	Initiates the Reset sequence to the BMC and support circuitry. After a Reset sequence is completed, the next BMC command must be an INITIALIZE or ABORT followed by an MBM PURGE command.
J	$\overline{\text{RD}}$	Input signal to indicate to the BMC that the user wishes to read one of the user-accessible registers.
K	$\overline{\text{WR}}$	Input signal to indicate to the BMC that the user wishes to write to one of the user-accessible registers.
L	$\overline{\text{DACK}}$	DMA acknowledge signal; indicates to the BMC that the next memory cycle is available for data transfer. If not used, it must be pulled up to V_{cc} with a 5.1K-ohm resistor.
M	DRQ	The data-transfer request signal; it indicates to the user system that the BMC is ready to transfer 1 byte of data to/from the user system when in the DMA mode; otherwise, it indicates that 22 bytes can be transferred.
N	INT	Interrupt line from the BMC to the user system. It indicates a change in the BMC status and requires service.
P	GND	Ground.
R through W	—	Not used.
X	+12V	+12-volt supply.
Y	$\overline{\text{7220 CS}}$	The BMC chip-select signal. Except during DMA operations, a high disables the BMC. When disabled, only $\overline{\text{RESET.OUT}}$ affects the BMC.
Z	GND	Ground.

Table 1: *Pin locations and signals for the bubble-memory card. Note the missing letters in the Pin Number column. This is the standard numbering sequence for 44-pin cards. Many of the signals are not used in this S-100 bubble-memory project.*

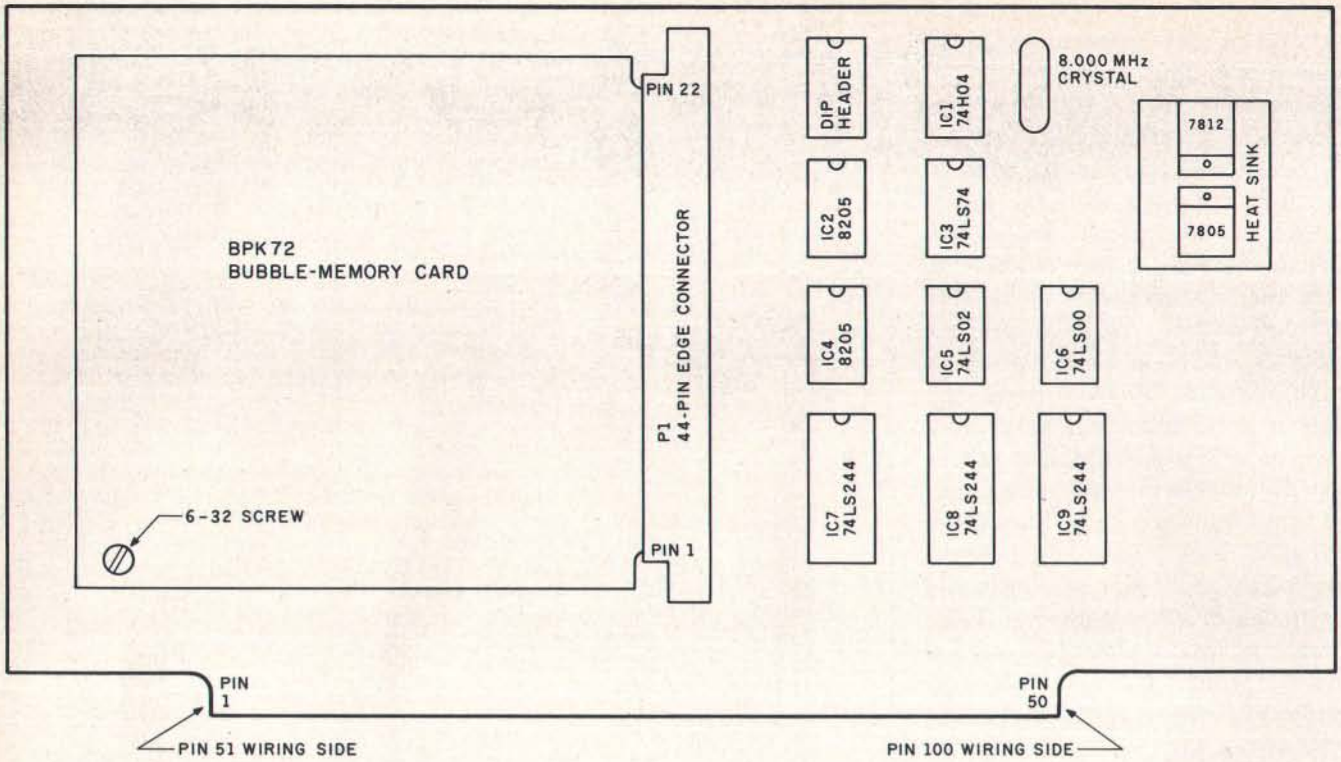

Figure 3: *The S-100 bubble-memory board parts layout shown here minimizes the length of signal lines.*

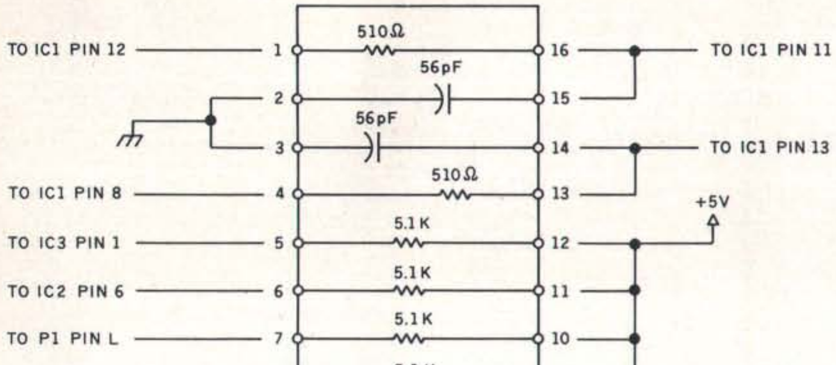

Figure 4: *This top view of the DIP header wiring diagram includes all the resistors and capacitors (except power-supply bypass capacitors) shown in the figure 2 schematic. All resistors are 1/4 watt.*

tied to the computer's Reset line. This is not the case. The $\overline{\text{RESET.OUT}}$ signal is an output signal from the on-board power-fail circuit, and, therefore, it should be left floating. To tie it directly to the computer's Reset line causes the on-board power-fail circuit to malfunction. Proper operation of the power-fail circuit is essential to the bubble memory's retention of data should the power fail and during the normal power-down sequence. It provides for an orderly shutdown of the bubble-memory system.

Parts Layout

Physical placement of the BPK 72 circuit board and interface components, figure 3, is designed to minimize the length of the signal lines. Looking at the component side of the S-100 wire-wrap board, most of the S-100-bus signals appear on the right-hand side of the signal pins. Therefore, to keep signal lines short, the S-100 interface circuit was located on the right and the BPK 72 PC card on the left. For the same reason, 74LS244 bus buffers (ICs 7, 8, and 9) were located at the bottom of the board closest to the signal pins. Because the oscillator has no off-board connections, it was located at the top of the S-100 board. All resistors and capacitors, except bypass capacitors, are mounted on a DIP (dual-inline package) header (figure 4).

S-100 Board Construction

The BPK 72 PC card is piggybacked onto the S-100 wire-wrap board (photo 3). To prevent shorting out of the foil side, I used a Vector Electronics wire-wrap board without foil pads or bus lines (VC8801-1). The 44-pin edge connector for the bubble-memory card presented the greatest problem in construction. I was unable to locate an edge connector with wire-wrap pins long enough to be bent at right angles, pass through the holes in the S-100 wire-wrap board, and still have sufficient length to accommodate two layers of wire-wrap. I solved the problem by using an edge connector with solder tails

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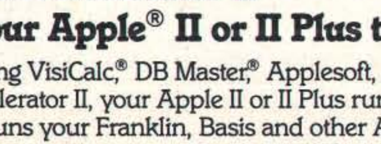

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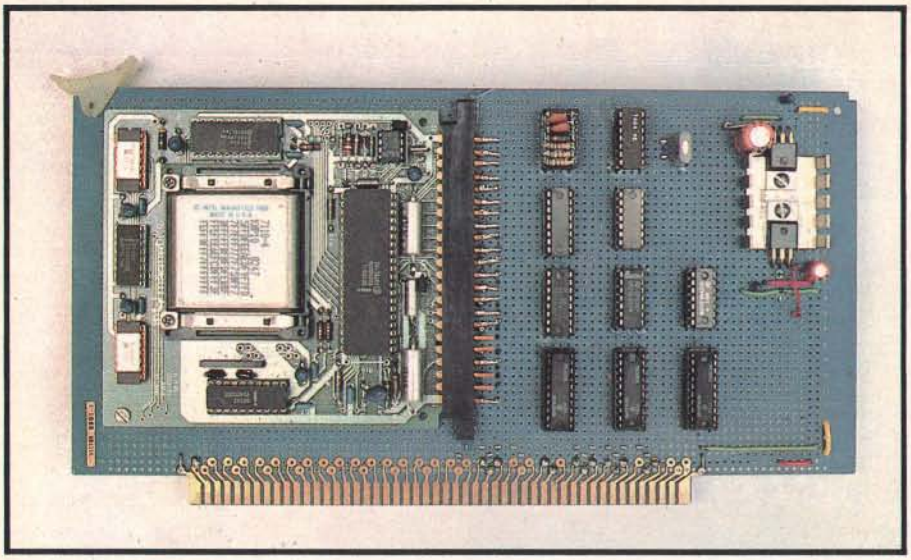

Photo 3: *The completed S-100 bubble-memory board's component side with the BPK 72 installed (see figure 4 for the parts layout).*

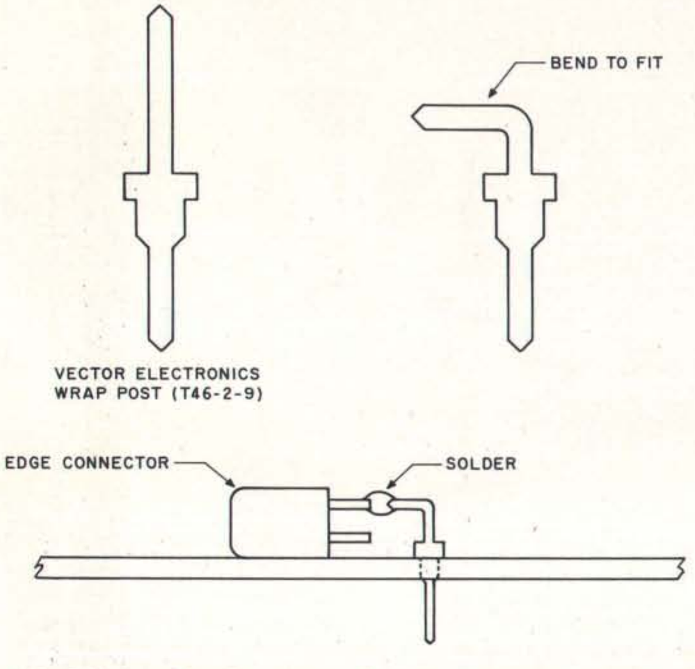

Figure 5: *A detailed view of the edge-connector fabrication using wire-wrap posts. Alternatively, the wiring could be brought up through the S-100 plug-board holes. See the text for details.*

and then bending wire-wrap posts (Vector Electronics T46-2-9), inserting them in the plug-board holes and soldering them to the solder tails on the edge connector, as shown in figure 5. Alternatively, an edge connector with wire-wrap pins can be used by passing the wires up through the holes in the S-100 wire-wrap board. I chose the first method, and the results are not as neat as I would have liked.

The 44-pin edge connector and all the IC sockets were attached to the S-100 wire-wrap board using one of the super glues. This type of adhesive has the advantage of being quick-setting and is strong enough for the task, yet it can be broken loose with moderate pressure applied with a screwdriver, in case of error or a change in design.

In order to provide additional mechanical stability for the BPK 72 card, I secured it to the S-100 board as follows: looking at the component side of the BPK 72 card positioned with the pins at the bottom, a small hole is in the clear area at the top left-hand corner. I enlarged the hole and drilled a matching hole in the S-100 wire-wrap board. After inserting the BPK 72 card in the edge connector, I secured the card to the S-100 board using a 6-32 screw and two nuts, with one nut between the two boards to serve as a spacer.

The power supply presented no special problems. The use of a heat sink for the two regulators is optional. I used red, yellow, and green insulated wire to indicate +5 volts (V), +12 V, and ground (GND), respectively, and white for signals (see photo 4). It makes tracing the wiring a little easier. Only two bypass capacitors are shown in the schematic, but more may be required, as discussed later. If your computer's power supply is small and/or heavily loaded, you may find it necessary to increase the value of the two 33-microfarad (μF) capacitors, as it is essential for correct operation of the power-fail circuit that the supply voltages not drop at too rapid a rate when either the computer is turned off or the power fails.

Preliminary Testing

Before installing the BPK 72 card in the edge connector or any of the interface ICs, install the S-100 board in the computer (an extender board is useful in making the following checks). Using an oscilloscope, check the output of the +5- and +12-V regulators for the correct voltage and any sign of noise. Also check for +5 V on edge-connector pins 8, F, and L, and +12 V on pins B and X. Remove the S-100 board from the computer and use an ohmmeter to check the edge-connector pins 1, 22, A, E, P, and Z for ground.

Next, install all the ICs—but not the BPK 72 card yet. Reinstall the S-100 board in the computer and then check the power-supply voltages again. If any noise is evident, bypass capacitors should be added to clean things up. Try 0.1 or 0.01 μF, if needed.

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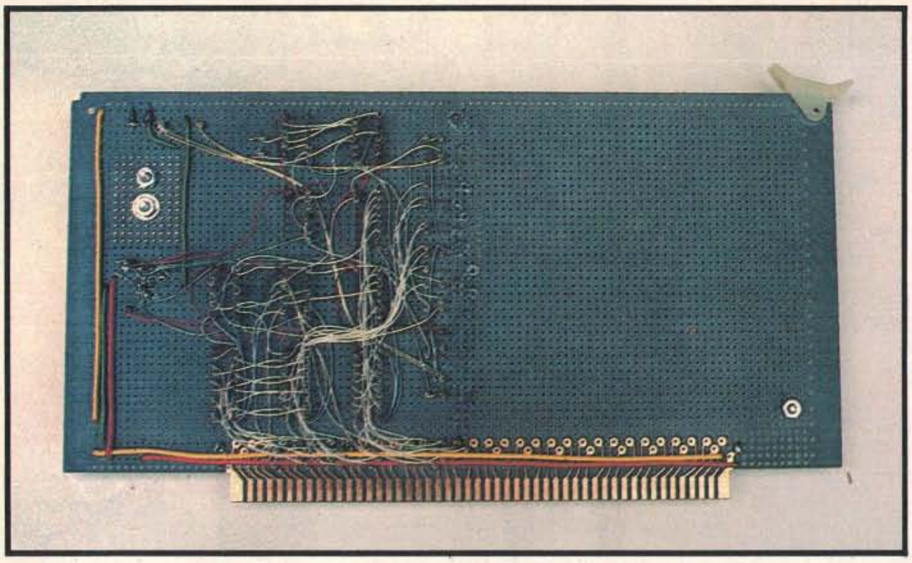

Photo 4: *The wiring side of the S-100 bubble-memory board. The following color code applies: red = +5 volts, yellow = +12 volts, green = ground, and white = signal.*

Using a 10-MHz, or higher, bandwidth oscilloscope, observe the 8-MHz oscillator output, pin 6 of IC1. The signal should be a reasonably clean square wave. If a frequency counter is available, measure the frequency; it should be between 7.992 and 8.008 MHz. Next, observe the clock signal on pin 4 of the edge connector. Without a load, some ringing may be evident; the frequency should be one-half the oscillator frequency.

If you haven't already done so, install the dummy module in the 7110 bubble-memory socket. The dummy module is an electrical equivalent of the 7110 bubble memory. It is intended to prevent accidental burnout of the 7110 bubble-memory chip during testing. Like the bubble-memory chip itself, it is keyed and can be installed only one way; the resistors should be visible once it is in place. A table of pin-to-pin resistances is in the users manual to check the module.

Turn off the power and insert the BPK 72 card in the edge connector and the S-100 board in the computer. At this point, a series of tests detailed in an application note (AP-119 supplied with the kit) should be conducted. The first test ascertains whether the power-fail circuit is functioning correctly by observing the RESET.OUT signal, pin 2 of the 7220 BMC. If there's a problem, you should not proceed with the remaining tests until the problem has been corrected.

The remaining tests call for the use of a program to condition the 7220 BMC and to determine its status. The software presented in the application note is written in 8088/8086 assembly language. However, the microprocessor I used is a Z80, and considerable differences exist between the two assembly languages. Rather than spend time translating routines that would only be used for the tests and then discarded, I decided to use BASIC INP and OUT commands. The idea worked just fine. In fact, I found that all bubble-memory operations can be performed using BASIC, except the actual transfer of data to/from the bubble memory. The reason that data cannot be transferred is that a BASIC interpreter is just not fast enough to keep up with a data-transfer rate of 100,000 bps, and this results in timing errors. The BASIC program in listing 1 is a collection of subroutines that I used for these tests. All that is required to use the program is to change the series of GOSUBs (lines 1070 through 1100) to select the desired functions for each test. Details of the tests themselves, along with the expected results, are spelled out in the application note, so I won't repeat them here.

A seed is a permanent bubble from which other bubbles are generated to represent binary ones.

All the BASIC programs presented in this article were written for Micropolis BASIC, which uses a slightly different form of INP and OUT commands. The following examples demonstrate how the instructions appear in Micropolis BASIC along with the more general form used in other BASICs (assume "P" is the I/O port to be addressed and "D" is the data to be written/read):

Micropolis BASIC	Other BASICs
OUT(P)=D	OUT P,D
D=IN(P)	D=INP(P)

Non-Micropolis BASIC users will have to revise the programs accordingly.

The last three tests in the series call for a program to cause certain signals to be generated. This can also be accomplished using the simple BASIC program in listing 2. The signal waveforms (as shown in the application note) are to be observed on various pins of the 7110 bubble-memory socket, which presented a problem because the solder side of the BPK 72 card is inaccessible when mounted on the S-100 board. Fortunately, all the test points can be found on the face of the dummy module. Location of the test points is easily determined from the schematic of the dummy module found in the users manual.

Final Testing

After successfully completing the preliminary tests, the next step is to install the 7110 bubble-memory chip. Power down and remove the dummy module, then install the 7110 bubble-memory chip. When power is reapplied, again monitor the RESET.OUT signal on pin 2 of the 7220 BMC. It should perform exactly as it did with the dummy module installed.

Before placing the bubble-memory system in operation, one final test is to be performed. Again using the test program in listing 1, load (write) the

Listing 1: *A collection of BASIC subroutines for preliminary testing of the BPK 72 Bubble-Memory Prototype Kit. The GOSUBs (lines 1070 through 1100) must be changed for each test.*

```
1000 REM ============ BPK-72 TEST ============
1010 REM
1020 D=224  :REM Data Port address
1030 S=225  :REM Status Port address
1040 REM --------------------------
1050 GOSUB 1130  :REM  Write parametric registers.
1060 GOSUB 1200  :REM  Display status.
1070 REM
1080 REM  Insert additional GOSUB's to select the
1090 REM  desired function and function order.
1100 REM
1110 STOP: END
1120 REM       --------------
1130 REM ----- WRITE REGISTERS
1140 REM       --------------
1150 OUT(S)=11  :REM Select 'B' register.
1160 DATA 01,10,08,00,00
1170 FOR I=1 TO 5: READ D1: OUT(D)=D1: NEXT I
1180 RETURN
1190 REM       ------------------------
1200 REM ----- DISPLAY STATUS [ IN HEX ]
1210 REM       ------------------------
1220 S0=IN(S)  :REM Input status.
1230 GOSUB 1270
1240 PRINT "STATUS = ";CHAR$(S1);CHAR$(S2)
1250 RETURN
1260 REM ----- CONVER DEC TO HEX
1270 S1=INT(S0/16)+48
1280 IF S1>57 THEN S1=S1+7
1290 S2=(S0 AND 15)+48
1300 IF S2>57 THEN S2=S2+7
1310 RETURN
1320 REM       --------------
1330 REM ----- WRITE 7220 FIFO
1340 REM       --------------
1350 FOR N=1 TO 40: OUT(D)=N: NEXT N
1360 RETURN
1370 REM       -------------
1380 REM ----- READ 7220 FIFO
1390 REM       -------------
1400 FOR I=1 TO 42
1410 S0=IN(D)   :REM  Get a byte from FIFO
1420 GOSUB 1270 :REM  Convert to Hex
1430 PRINT CHAR$(S1);CHAR$(S2);" ";
1440 NEXT I
1450 PRINT
1460 RETURN
1470 REM       -----------------------
1480 REM ----- 7220 CONTROLLER COMMANDS
1490 REM       -----------------------
1500 INPUT "ENTER COMMAND (IN HEX): "; C$
1510 C=0: IF LEN(C$)<>2 THEN STOP
1520 T=ASC(LEFT$(C$,1)): GOSUB 1560
1530 C=C*16
1540 T=ASC(RIGHT$(C$,1)): GOSUB 1560
1550 RETURN
1560 IF T=>48 AND T<=57 THEN C=C+(T AND 15)
1570 IF T=>65 AND T<=70 THEN C=C+((T AND 15)+9)
1580 RETURN
```

Listing 2: *A simple BASIC program to generate the signals required for testing the BPK 72.*

```
1000 REM ======= COIL DRIVE SIGNAL GENERATOR =======
1010 REM
1020 D=224  :REM Data Port address
```

Listing 2 continued on page 380

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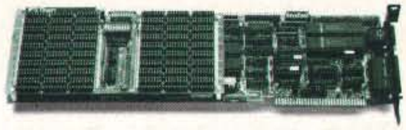

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Listing 2 continued:

```
1030 S=225  :REM Status Port address
1040 REM ----------------------------
1050 INPUT "GENERATE READ OR WRITE SIGNALS (W/R): ";C$
1060 OUT(S)=25: OUT(S)=30: OUT(S)=29 :REM Clear 7220
1070 REM         ---------------
1080 REM ----- WRITE REGISTERS
1090 REM         ---------------
1100 OUT(S)=11  :REM Select 'B' register.
1105 RESTORE
1110 DATA 01,16,08,00,00
1120 FOR I=1 TO 5: READ D1: OUT(D)=D1: NEXT I
1130 REM ----------------------------
1140 IF C$="W" GOTO 1230
1150 REM         ------------------
1160 REM ----- GENERATE READ SIGNAL
1170 REM         ------------------
1180 OUT(S)=18  :REM  Send read command (12 Hex)
1190 K=IN(D)
1200 IF (IN(S) AND 32) = 0 GOTO 1190
1210 GOTO 1180
1220 REM         -------------------
1230 REM ----- GENERATE WRITE SIGNAL
1240 REM         -------------------
1250 OUT(S)=19  :REM  Send write command (13 Hex)
1260 OUT(D)=255
1270 IF (IN(S) AND 128) <> 0 GOTO 1260
1300 GOTO 1100
```

parametric registers and display the status. You should obtain a status of 40 hexadecimal, indicating that operation is complete. The test program can then be modified by changing the DATA statement and GOSUBs to permit checking the seeds, as described in the application note. A seed is a permanent bubble in the magnetic-bubble memory, from which other bubbles are generated to represent binary ones. Checking the seeds also checks the boot loop written into the bubble memory at the factory and listed on top of the 7110 bubble-memory chip. As I explained earlier, the boot loop maps defective and unused data loops. Should there be an error in the boot loot, a simple procedure in the users manual shows how to rewrite it. If one of the seeds is missing, things become a bit more complicated. Missing seeds can be restored, but a special hardware subassembly, supplied with the kit, must be used. This procedure is also explained in the users manual. I did not experience any difficulty with either the boot loop or the seeds.

Next Month

This concludes part 1 of this article. Next month, we'll go beyond the construction and preliminary testing into the software requirements needed to make the magnetic-bubble-memory board work with Micropolis MDOS and CP/M.■

[**Editor's Note:** *As this article went to press, Intel announced a change in the configuration of its BPK 72 Bubble-Memory Prototype Kit. Now labeled the BPK 72A, this kit comes assembled and tested, but you still must add an edge connector, an S-100 bus interface, and power-supply circuitry as described here. A different testing procedure is required, but it, too, is documented in the new kit. The current chip uses a socketed leadless package, but a chip with leads (no socket) and clock should be available in January.*

The BPK 72A kit is available for use in three temperature ranges: Standard, BPK 72A-1 (0-75°C), Commercial, BPK 72A-4 (10-55°C), and Military, BPK 72A-5, (−2-+85°C). As a promotional item, Intel is offering the Commercial kit for $199 through any local Intel distributor. If your computer environment holds within the 50-131°F temperature range, the Commercial kit could provide 128K bytes of nonvolatile memory at considerable savings.]

Louis Wheeler is a retired federal government employee. He spent 14 years as a programmer, teacher, and manager of minicomputer systems. His special interest is data processing, in which he has an associate degree. He can be contacted at 1323 Tamera Dr., Oceano, CA 93445.

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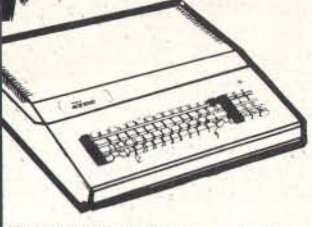

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Mockingbird: A Composer's Amanuensis

This display-oriented music-notation editor can help composers capture their ideas

by John Turner Maxwell III and Severo M. Ornstein

The Xerox Mockingbird is a composer's amanuensis, a computer program designed to aid a composer in capturing, editing, and printing musical ideas. The purpose of Mockingbird is not to invent new music or to suggest variations to the composer, but simply to aid him in recording his own ideas by speeding up the notation process. Mockingbird is not a publisher's aid, although it does print music, nor is it a performer's aid, although it can play; it is strictly focused on the composer's need for a powerful scribe.

Mockingbird is an interactive music-notation editor. It knows nothing about the rhythmic, harmonic, or melodic aspects of music except as they are represented in common music notation. To narrow the scope of Mockingbird, we at Xerox concentrated on handling piano music. The program presently cannot handle orchestral scores or music for instruments that require their own notational devices.

Mockingbird was written in 1980, and we find it surprising that no one had previously built such a system. We believe there are two principal reasons: first, we had at our disposal an unusually powerful set of hardware and software facilities with excellent graphics capabilities, and second, we made a number of key decisions, discussed later, that allowed us to bypass some difficult problems.

This article originally appeared, in somewhat different form, in a Xerox report of the same name.

Overview

Mockingbird is written in Mesa (see references 1 and 2), an experimental language developed at the Xerox Palo Alto Research Center (PARC). Mockingbird runs on a general-purpose computer called the Dorado (see reference 3), a powerful, experimental, single-user machine also developed at PARC. (The Dorado is now officially known as the Xerox 1132.) It has a 60-nanosecond instruction cycle, a large memory (typically 2 to 8 megabytes of RAM), and an 80-megabyte disk. It also includes a large, high-resolution bit-map display, a keyboard, and a mouse. Mockingbird presents a picture of a score on the display. The mouse provides the mechanism by which the user can point to locations within the score or to particular items, such as notes, to which some action is to be addressed. It has three program-readable push buttons on its top that are used for issuing commands to the program (sometimes in conjunction with keyboard keys).

The graphics facilities, high speed, and large memory make the Dorado a particularly suitable tool for music editing. The only special hardware we provided for Mockingbird was an interface to a Yamaha CP-30 electronic synthesizer. The Dorado can sense key positions and simulate key strokes on the synthesizer. Thus, the synthesizer can be used to "play in" music and to let the computer "play back" music without having to synthesize the sound waveforms by program. The setup is shown in photo 1. Not shown is an experimental high-resolution, computer-driven, raster-scan laser printer that Mockingbird uses to make hard-copy pictures. The information for these pictures is sent over an Ethernet (see reference 4) connection from the Dorado. (Figures 1 and 2 illustrate Mockingbird's hard-copy output.)

In addition to these hardware resources, Mockingbird relies heavily on a general-purpose graphics software package (see reference 5) that provides simple commands for displaying characters and drawing both lines and curves. It also provides a common interface for both displaying material on the screen and printing high-resolution hard copy.

Mockingbird is designed to handle standard piano-music notation. It knows how to deal with notes, rests, accidentals, beams, chords, ties, grace notes, n-tuplets, time signatures, key signatures, clef indications, ottava, and a variety of different kinds of measure lines, embellishments (mordents, etc.), and sheet layouts (see the glossary on page 401 for definitions of these and other musical terms). Mockingbird deals with these elements not only in the graphics but, where appropriate, in the playing as well. Mockingbird understands about the key of a piece and will propagate and properly suppress accidentals.

Despite its sophistication, the

Photo 1: *The Mockingbird user's setup.*

Mockingbird editor is only a research prototype. Many features are still missing and, in general, we did only enough to demonstrate feasibility. For example, there are numerous notational devices that we never incorporated in the program, such as rolled chords, staccato markings, fermata, and so on. Furthermore, although Mockingbird can handle ties, it cannot handle the more general slurs, nor can it display text such as lyrics or tempo markings. We do not feel that the addition of further features would present any insurmountable problems or violate the premises from which we proceeded.

Important Decisions

We feel that Mockingbird's success is largely dependent on the decisions we made in the following five critical areas.

Scribe vs. Automatic Transcriber—We decided not to try writing a program that converted synthesizer keystrokes directly into a score. We made this decision for a number of reasons. First, we weren't sure that it could be done for the class of music we were interested in. Rather than pursue that question, we wanted to produce a tool that worked. Second, we knew that an editor would be needed anyway, both to correct mistakes and to satisfy the composer who did not want to use the synthesizer keyboard to enter material. So, instead of a recognizer, we built an amanuensis, or scribe, that provides a human transcriber with powerful editing tools. Our strategy was to build the editing tools first and then work on automatic heuristics to augment the editing process. The editing tools can assist either in performing the conversion from played input to score or in entering scores graphically.

Data Structure—We believe that one of the most important decisions we made was the choice of data structure. Mockingbird treats music simply as a sequence of events. This allows us to simultaneously handle raw ("played in") material and more finished ("structured") material. Furthermore, it is convenient for presenting the material in its various external manifestations—displayed, printed, and played.

User Interface—In Mockingbird, rather than doing a lot of typing on the computer's keyboard, the user operates directly on the picture of the music that appears on the screen. To do this, he makes heavy use of the mouse. This approach is facilitated by a strong correlation between the internal representation of the music and its visual display (as well as how it is played). All of the elements of the data structure are displayed, and everything shown on the screen corresponds to some part of the data structure. If the user moves something on the screen, the data structure is immediately updated to reflect it; if the data structure is changed, the screen is immediately repainted. Not only is the picture faithful to the data structure, but so is the synthesizer "performance." For example, if the user puts a trill marking on a note, Mockingbird will trill when playing it.

Piano—Music notation is extensive and nonuniform—instruments present individual requirements and employ special notational devices. By choosing to focus our attention specifically on piano music, we limited the scope of our ambitions to a manageable size. The piano was an obvious choice as it is an instrument frequently used by composers in trying out their ideas. Furthermore, because of its keyboard structure, it lends itself naturally to connection as an I/O (input/output) device to a computer.

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into separate parts or voices. Such partitioning is obvious in multiple-instrument music, but it is also an essential structural feature in piano scores. The recognition of this fact, and its explicit representation in Mockingbird, greatly facilitates the editing and formatting of scores. This topic is discussed later.

The Editor

Mockingbird consists of a number of functionally distinct parts integrated into one editor. The editor allows the user to record, edit, play, and print a single piece of music. Commands are issued by making selections and typing characters. Some commands are invoked by pointing the mouse at an object on the screen and clicking a button. When the user has finished with the piece of music, he can name it and file it away in the Dorado's filing system. Later it can be retrieved by its name.

As it appears on the display, a score looks like a piece of sheet music (see photo 2). There are usually four to six staff sets (lines), each composed of two to four staves. At the left of each staff is a clef sign and an appropriate key signature. Scattered over the staves are notes, chords, beams, measure lines, and other symbols commonly found in music.

Only about a page of the score can appear on the screen at a time, so there are commands that allow the user to look at different sections. Scrolling causes the current section of the score to be moved up or down so that neighboring lines can appear. The user can scroll as little as a single line or as much as an entire page. Thumbing allows the user to jump to an arbitrary point in the score. To thumb, the user specifies approximately how far into the score he would like to be, and the program moves the display to that point. Both thumbing and scrolling are accomplished by moving the cursor into a special "scroll bar" area at the left of the score and clicking one of the mouse buttons.

The score can be edited with Mockingbird just as documents are edited with word processors. The usual paradigm for making an edit is to "select" some portion of the music and then to issue a command. The command will apply only to the selected portion. The display is updated immediately to reflect the changes.

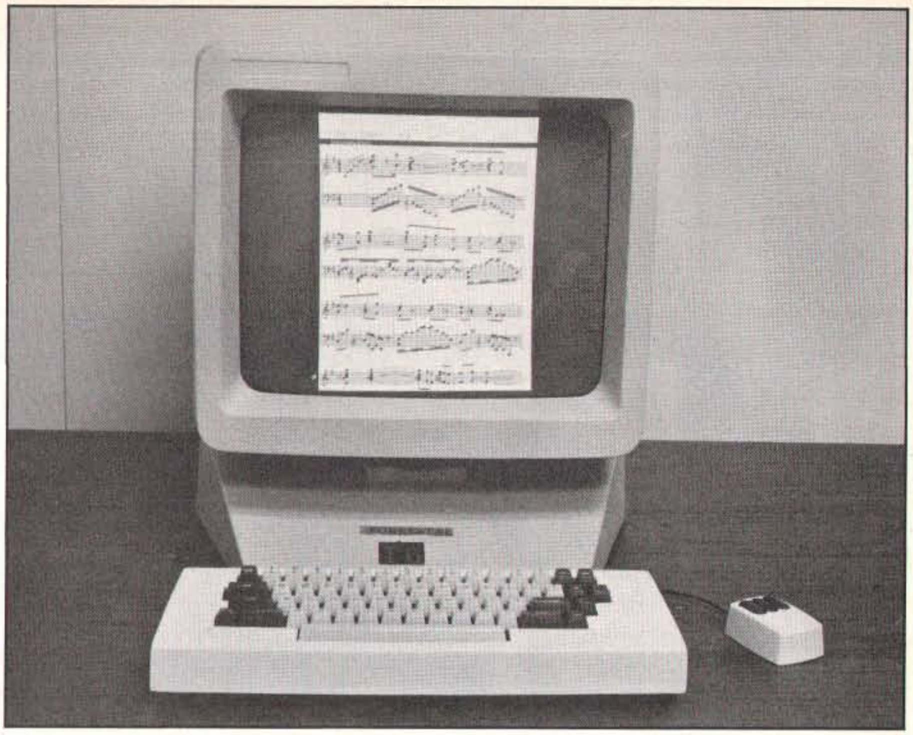

Photo 2: *A computer running the Mockingbird program.*

Selection

A user may select either a contiguous section of the score or an arbitrary collection of individual notes. Both types of selections are made by moving the mouse over the desired objects while holding down a mouse button.

If the user selects a section of the score, Mockingbird indicates that section by displaying it in reverse video (white on black instead of black on white). The section may be as small as a portion of the measure or as large as the entire score. It encompasses all of the notation that appears on all of the staves. Section selection is typically used for coarse editing operations such as copying and deleting. However, it may also be used to apply a function to all of the notes in a particular region, such as designating them all to be sixteenth notes.

Mockingbird indicates individual note selections by painting the selected note heads gray. An individual note may be selected by pointing at it with the mouse and clicking the left mouse button. Notes may be collected into a selected set for combined action either by a series of individual mouse clicks or by sweeping the mouse over the note heads while holding down the mouse button.

Because selection persists after execution of a command, it is possible, with a single selection, to issue a succession of commands that all apply to the same material.

Voices

To play notes at the proper time and to place them correctly within the score, it is necessary to know where they occur within the rhythmic structure of the piece. Measure lines provide reference points from which rhythmic position is measured. For music that has only one voice, you start at the beginning of the measure and count forward through the various note and rest values until arriving at the note of interest. Its position in the measure's rhythmic structure is then given by the sum of the time values of these preceding items. If the music has several parallel voices with differing time values, you must know which

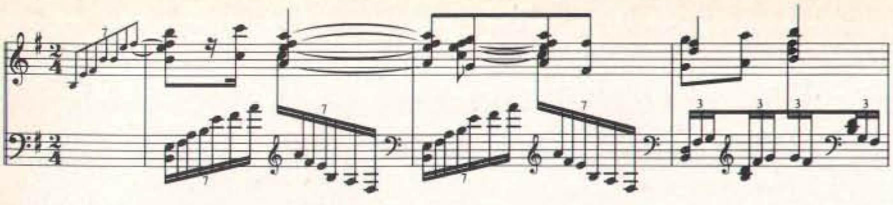

Figure 1a: *A segment of a piano score.*

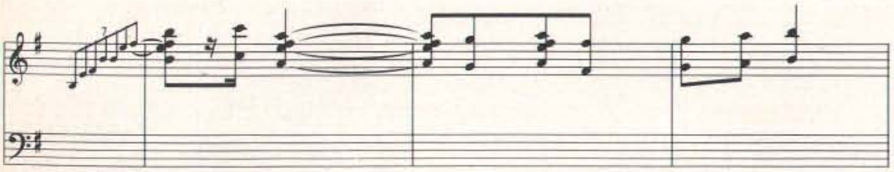

Figure 1b: *The same segment showing only voice one.*

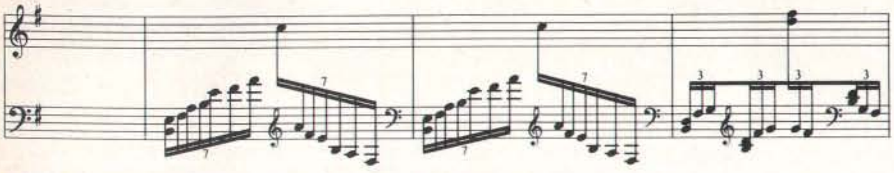

Figure 1c: *The same segment showing only voice two.*

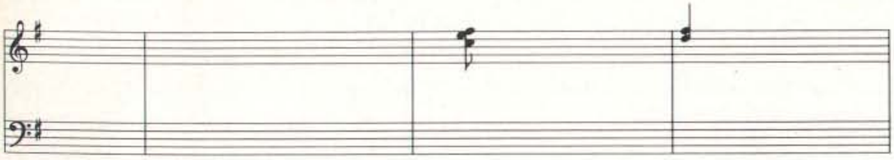

Figure 1d: *The same segment showing only voice three.*

notes belong to which voice in order to count forward properly. Voicing thus provides a lateral indication of what goes with what.

Figure 1a shows a section of a full piano score, whereas figures 1b-1d show its separate voices. To find out when the C octave occurs in the second measure of figure 1b, add the prior eighth chord and sixteenth rest and conclude that the octave comes three-sixteenths into the measure. Now consider the situation in the third measure of figure 1d. Here a voice commences within the measure rather than at its beginning, so there is no way to count forward to it. Instead, its rhythmic position is determined by its synchrony with an element of another voice, in this case, the octave in voice one. (To enhance visual clarity, the chords are slightly separated in the full score shown in figure 1a. However, they are, in fact, rhythmically synchronous.)

In that same measure, consider the effect of erroneously placing, say, the sixth note of voice two in voice three. The effect would be significant: first, the note would be incorrectly located (played) at the midpoint of the measure (i.e., one-eighth after the chord in voice three), and second, due to the omission in voice two, all the ensuing notes of that voice (up to the next reference point) would be located slightly earlier than they should. Mockingbird contains a mechanism to assist the user in finding such errors. Upon request, the program will check to see whether the rhythmic "time" of every measure is properly filled by the notes and rests of the voices it contains (with due allowance for parallelism of voices). Measures that don't "add up" correctly will be marked with a stipple pattern on the display.

The voicing of a piece of music is hence an important part of its underlying structure, which is revealed by the way in which the score is drawn. Thus, voicing in a piano score is indicated by such clues as shared beaming, chording, stem direction, and staving. The reader uses these clues, together with vertical alignment within the score, in determining how to play the music, i.e., when to play the notes, which hand to use, etc.

In Mockingbird, the problem is the converse one of determining what the finished score should look like, starting from raw notes that have neither explicit voicing nor any of the structural clues of a completed score. Everything must be determined from scratch: note values, chords, staving, beaming, rests, ties, etc. One of our earliest insights was that if we could first determine the voicing of a piece, it would greatly facilitate determination of all of these other features. In studying existing piano scores, we saw no general way to infer voicing automatically, and so instead decided to give the user explicit control over its definition. Hence, Mockingbird includes commands for assigning notes and rests to voices and for indicating synchrony between the elements of different voices.

Once a piece has been voiced, the user can designate a particular voice for viewing, in which case the notes of that voice appear in black on the display while the rest of the score appears in a light gray for reference. In this mode, the user can access only items within the designated voice (i.e., area selection will select only the notes in that voice, and individual notes in other voices cannot be selected). Any editing commands issued when viewing a single voice will thus affect only that voice; the part displayed in gray is not affected.

Editing Commands

Mockingbird's editing commands include assigning note values, assigning notes to voices, transposing notes, changing their stem direction, changing their spelling, and changing the staff on which they appear. In addition, various elements of the score, such as notes, measure lines, and time, key, and clef signatures, can be individually deleted or picked up and moved to a new location with the mouse. There are also commands that group notes together with beams,

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chords, or slurs. Many of these commands work with either note or section selection. For instance, the user may transpose a single note down an octave or an entire voice up a fifth. The first of these actions would be accomplished by selecting the note and issuing the Transpose command. The second would be accomplished by designating the desired voice, selecting the entire score, and issuing the command.

The user may also rearrange large sections of the score in a "cut and paste" manner. To replace one section of the score with another, the user selects the section to be replaced (the primary selection), then the section to be copied (the secondary selection), and issues the Replace command. The primary selection does not have to be the same size as the secondary one. If there is no secondary selection, the resulting operation is a deletion. If the primary selection merely points at "empty space" in the score, the resulting operation amounts to an insertion.

In addition to changing the structure of the music, the user can change the way it appears on the sheet. For instance, the number of staves for each line can be changed on a line-by-line basis. The user can switch a staff's clef in the middle of a measure or designate a section to be displayed in ottava notation. Changes in key and time signatures can also be inserted within the score wherever necessary.

The user can add new material to the score by picking up items from a pop-up menu that can be made to appear under the cursor (see photo 3). The menu includes a number of small symbols (called *icons*) representing various elements of the score. There are icons for a note, a rest, bass and treble clefs, several kinds of measure lines, and a variety of markings such as trills, accidentals, etc. As the cursor is moved over the menu, its shape changes to correspond to the icon immediately beneath it. When the mouse button is released, the cursor retains the last shape. The user can then insert instances of that icon by pointing to a place in the score and clicking another mouse

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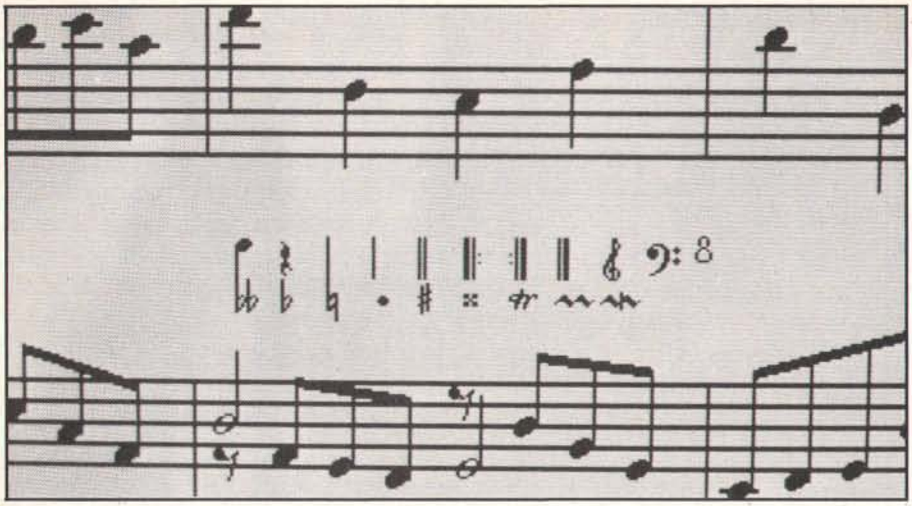

Photo 3: *A photo of the display screen showing the pop-up menu.*

button. (Mockingbird automatically selects the inserted note or rest for the user's convenience. Thus, the user may immediately issue commands that affect the note.)

The Synthesizer

The synthesizer is both an input and an output device. As an output device it can be used to listen to music stored by Mockingbird. This is especially helpful in proofreading scores. Mockingbird "reads" the score and plays it by simulating key strokes on the synthesizer. As the synthesizer plays the notes, a pointer tracks the performance on the displayed score. Mockingbird's rendition handles polyphonic music correctly, taking into account such things as grace notes, n-tuplets, trills, ottava, and metronome markings. Thus, the composer may listen to what he has written. Although the performance sounds a little mechanical, it is sufficient for catching erroneous note values and pitches. Moreover, the music can be played at double speed for rapid scanning or half speed for careful listening.

As an input device, the synthesizer is used to capture music played by the composer. As the user plays, Mockingbird "watches" the keys and records when every note was struck. Music in this form is displayed as a note-head time plot, which we call a "piano roll," illustrated in figure 2a. Mockingbird chooses default staffing and spelling. Figure 2h shows the final score for this same section of music.

When playing music, the composer isn't restricted to a single melodic line, nor must he follow a metronome; he may play whatever he wants as freely as he wishes. Mockingbird captures his idea in a rough form that, although a far cry from a standard score, nonetheless contains enough information to reconstruct his original intent. At this point, the composer may go on to capture more music or start transforming the piano roll into a score by editing it.

Raw piano-roll material can be mixed in freely with standard music notation, both on a measure-by-measure basis and within a single measure, as shown in figure 2c. All of the commands that apply to standard music notation can also be applied to the piano roll or to mixed sections. Thus, the composer can rearrange material, put notes into different voices, specify the durations of the notes, and add structural elements such as beams and chords. The ability to mix piano-roll and standard music notation gives the user a lot of freedom; he can work on the score in whatever order pleases him. Mockingbird even plays correctly across the boundaries of mixed sections of piano roll and standard music notation.

Another feature of Mockingbird is that it is possible to "play against" previously entered material. While Mockingbird plays, the user can play along with it on the synthesizer. The combined product is heard as Mockingbird records the new notes, simultaneously merging them with what it is playing. This allows the composer to build a piece one voice at a time or to lay in new material over an existing score. It also allows him to construct music that cannot be played by one person on a standard instrument.

Converting Piano Rolls

Figure 2a shows some source material recorded by Mockingbird directly from the synthesizer. Such raw piano rolls are hard for humans to read; there are no key or time signatures, no measures, chords, or beams to group things, nor have the notes been separated into voices. Because part of the composition process includes specifying such syntactic structuring, it was necessary for Mockingbird to go beyond piano-roll notation. The process of converting from piano-roll to standard music notation is not handled automatically, but rather involves the user. However, Mockingbird does provide a number of heuristics that assist in the transformation.

Figure 2 shows a typical succession of steps for turning some piano-roll input into a final section of score. At any point, the composer can use the mouse and menu to add material, because Mockingbird allows piano-roll and standard music notation to coexist.

The first step in converting piano rolls is alignment. To remove the inevitable imprecision in playing notes

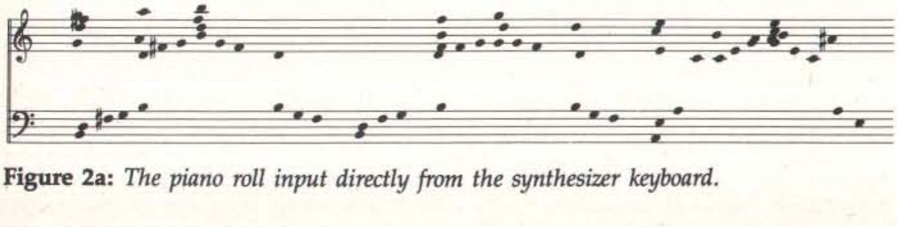

Figure 2a: *The piano roll input directly from the synthesizer keyboard.*

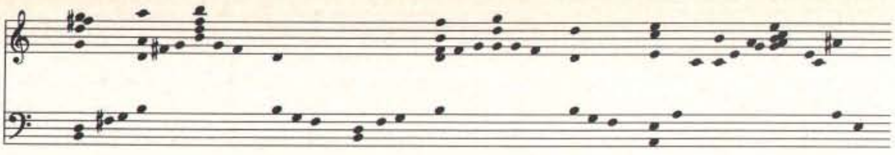

Figure 2b: *The piano roll after alignment.*

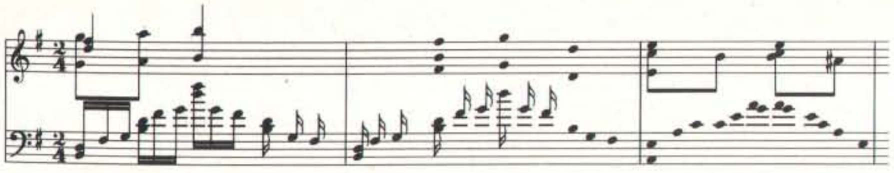

Figure 2c: *The piano roll with key and time signatures, voicing, measure lines, some time values, beams, etc., added by the user.*

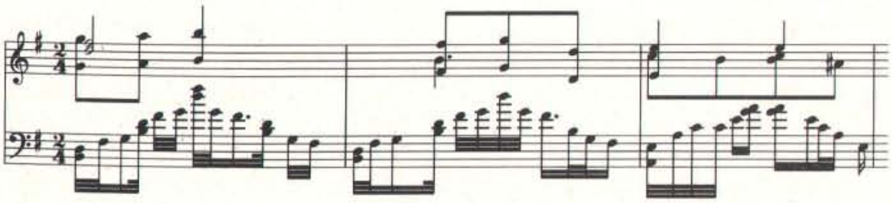

Figure 2d: *The results of timing and beaming heuristics.*

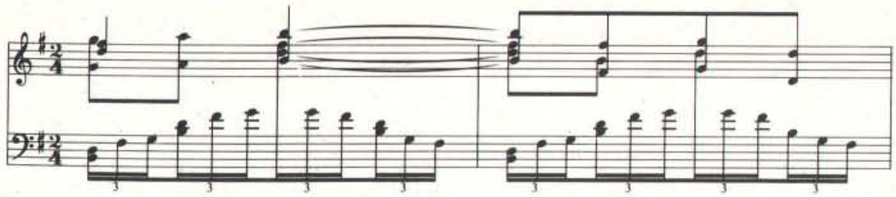

Figure 2e: *The piano roll justified with too low density.*

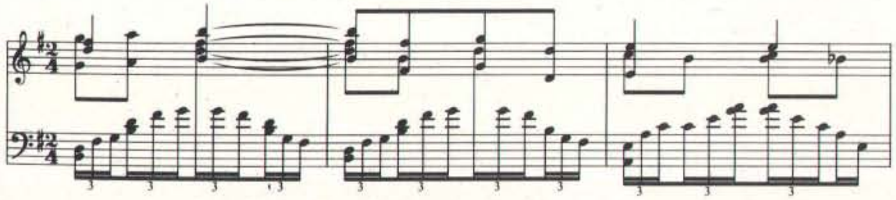

Figure 2f: *The piano roll with a more suitable density.*

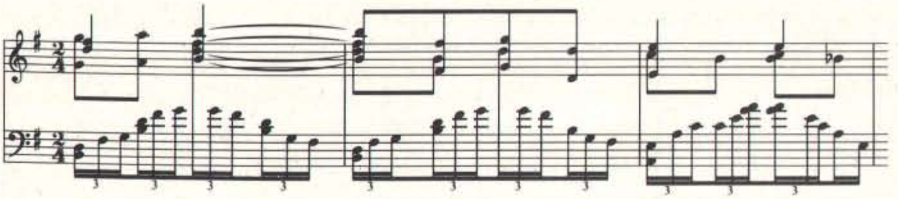

Figure 2g: *The piano roll after correction by the user.*

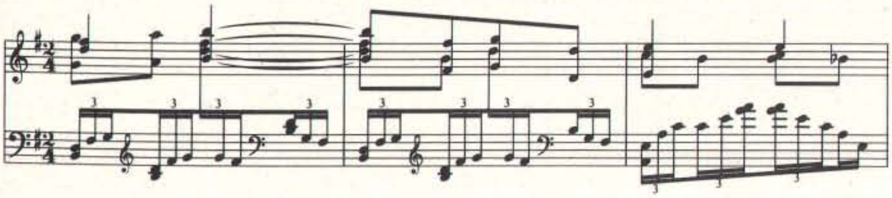

Figure 2h: *The piano roll after final "hand" touch-up by the user.*

that should be simultaneous, the user can apply a heuristic that runs through the piano roll and aligns the notes that occur close to the same time. Figure 2b shows the results of that step.

Typically, the user provides key and time signatures in the next step, then he might enter measure lines. He can do this by picking up a measure-line icon from the pop-up menu and depositing copies at suitable places into the piano roll. Alternatively, the user can tell Mockingbird to play the piano roll back on the synthesizer, and as it does so, he can "beat in" measure lines simply by striking the keyboard's space bar on the first beat of each measure. Errors can easily be corrected by moving, deleting, or inserting measure lines as appropriate.

Next, the user would normally assign notes to different voices. An individual note is assigned to a voice when the user selects the note and then indicates to which voice it belongs. More typically, collections of notes are simultaneously voiced by selecting them together and then issuing a single voicing command.

At this point, the user can go through the score, manually assigning time values to the notes and designating chords and beams. Figure 2c shows this process partially completed. However, Mockingbird has a number of heuristics to help with these tasks. After the user assigns notes to their proper voices and gives a time signature, he may ask Mockingbird to *guess* the time values of the notes, group them into chords, and assign beams. Although the heuristics used are only about 80 percent accurate, they save the user a lot of work. In addition, what remains is easier for the user to deal with, because it is in a more familiar form. Figure 2d shows the result of the heuristics. Mistakes made by the heuristics can be found by inspecting the score or listening to it through the synthesizer. The user then fixes the mistakes and adds more structure. Figure 2g shows the resulting score. The combination of simple heuristics and easy editing is as central to the

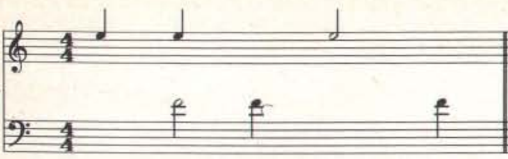

Figure 3a: *Two voices improperly aligned.*

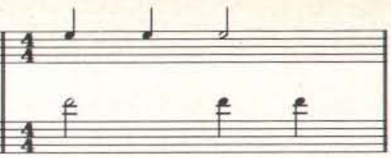

Figure 3b: *The same two voices after correction by the justifier.*

concept of Mockingbird as an amanuensis.

By the time these steps are completed, the piano roll has become a score containing all the basic information. The only thing that remains to be done is some tidying up.

Justification

A particularly powerful command is the one that justifies a sequence of measures within the score. (The user selects some area of the score, and the justifier locates the nearest measure lines.) Justification involves several things: making the voices consistent relative to one another, laying out the graphical elements of the score in an aesthetic arrangement, and making sure that each line of the score contains complete measures. Justification is concerned only with the *horizontal* placement of objects; details such as the height and tilt of the beams are outside of its domain. Furthermore, it doesn't disturb structural elements such as stem directions and staffing.

The justifier starts by going through each measure and making sure that all of the voices are consistently ordered relative to one another. Two voices are inconsistent if each adds up to the time signature, but when taken together, allowing for alignments and spacing, they appear to add up to more than the time signature. Figure 3a shows an example of such a situation. The justifier moves notes around to correct matters, as shown in figure 3b.

Next, the justifier redetermines the horizontal placement of the graphical elements of the score. The horizontal spacing is based on the types of elements (measure line, note, clef sign, accidental, etc.), the voicing, and the need to keep things from overlapping. The user can also give a parameter that determines how "dense" the justification should be. The justifier then squeezes things together as close as possible based on these constraints.

Finally, the justifier stretches out the spacing in the material to make an integral number of measures fit on each line. The user can justify various sections of a piece with different densities as appropriate (see figures 2e and 2f).

If at any point the user is dissatisfied with the results of justification, he can manually move items around in the score to improve the appearance. However, the justifier produces a surprisingly good layout, so that usually the only things left for the user to do are adjustments that en-

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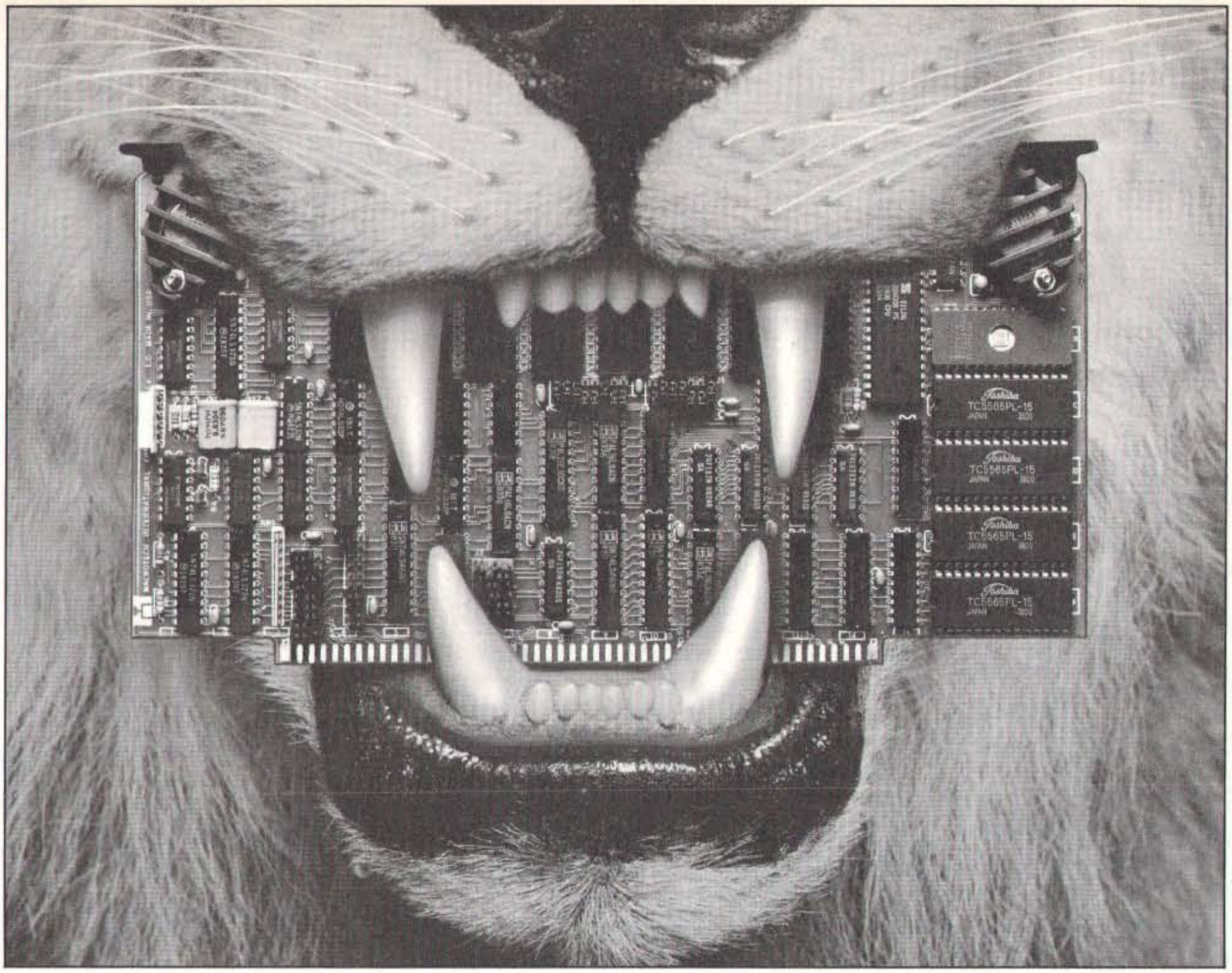

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hance readability (such as grouping and tilting beams, adding clef switches, etc.). In fact, given the power of the justifier, one common style of use is to enter music one voice at a time, not worrying at all about the spacing between notes. Each time a line of material has been entered, the user justifies that and then goes on to the next line. The justifier takes care of aligning the voices properly and producing a suitable layout.

The justifier is also helpful in determining page layout and page breaks. The user can indicate that specific measures are to fall at the end of a line. The justifier takes this into account when deciding how many measures to put on a line. With this feature, the user can control how many pages the score will fill and can assure that the end of the score falls at the end of a page.

Data Structures

Our first design was a hierarchical data structure that closely matched the formal structure we saw in music. But we ran into numerous problems with it because it didn't match the needs of an editor. After much discussion, we settled on a sequential data structure. This surprised us, because in the beginning we had thought that the hierarchical design was the obvious choice. However, experience has convinced us that the sequential design is vastly superior.

There are three considerations in designing a data structure: representational power, programming convenience, and performance. Representational power concerns how much of the domain is covered by the data structure and how easy it is to represent different aspects of the domain in the structure. Programming convenience concerns how easy it is to write algorithms that deal with the data structure. This depends a great deal on what the algorithms do. In Mockingbird we are mostly concerned with playing, editing, and displaying the score (as opposed to structural analysis or automatic composition). Performance concerns how rapidly the data may be accessed. Even if a data structure is convenient, it may not be efficient. Sometimes there is a trade-off between structural complexity, memory utilization, and speed. In Mockingbird, memory was plentiful and speed was critical; for an editor to be useful, the display must respond crisply to user actions.

There are many possible hierarchical data structures that might be used to represent music. We use the term loosely to describe a class of data structures that implicitly incorporate musical structure in the design. Thus you might imagine a data structure that had a separate part for each measure or for each voice. A "sequential" data structure, on the other hand, is simply a sequence of undifferentiated entities. No attempt is made to incorporate musical structure into the design. Instead, it is up to the algorithms to determine the structure from the entities.

On the surface, the hierarchical design seems better. If the musical structure is built into the data structure, then you can guarantee a uniform interpretation over all of the

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algorithms. Not only that, but algorithms won't have to derive the built-in information.

Unfortunately, basing the data structure on the musical structure was too constraining. We wanted a uniform representation for both common music notation and piano rolls so that the user could mix both types of music freely. Although it might be possible to keep a separate data structure for piano rolls, it would make the algorithms for editing, displaying, playing, and justifying much more difficult. All of these algorithms need to know what things are near one another. A simple example is redisplaying the score after a small edit has been made. For efficiency, we would like to redisplay as little of the score as possible. But that requires knowing what objects are near the entity that was edited. In the hierarchical design, an entity that is close physically may be logically far away. It might be in another measure, voice, or chord, or on a different staff. Enumerating all of the possibilities is inconvenient and time-consuming.

In addition to all this, there is the problem of exceptions. Many of the rules of notation that are presumably inviolable turn out to be violated when the composer finds the notation too constraining. A design that has fixed rules about the structure of music built into it won't be able to handle such exceptions. Even if the exceptions were ruled out, you would still have problems with the inconsistent structures that arise temporarily during editing. We wanted our design to be tolerant of such exceptions and inconsistencies.

A sequential design doesn't have these problems. It allows piano rolls to be mixed with standard music notation because both are represented as ordered sequences. Finding things that are nearby is easy, because things that are near one another on the screen are near one another in the data structure. And finally, because the data structure is so unstructured, it is flexible enough to handle a wide range of exceptions.

Mockingbird's "sequential" data structure is simply a sequence of events ordered by time. An event might be a measure line, a collection of notes, a time signature, a clef change, or a change in the number of staves per line. The events that contain notes are called "syncs" because they synchronize all of the notes in the event. (That is, all of the notes in the sync are played or displayed together.) The notes may belong to different voices or chords, but they all have the same "time." The editor automatically synchronizes notes that are very close to simultaneous whenever notes are entered or moved. Occasionally this will introduce an error, which can be fixed by the user.

Syncs are important because they keep simultaneous notes together while the score is being edited. Usually, if the composer plays several notes at the same time, he wants them to stay together unless he explicitly says otherwise. Inserting a note before a sync shouldn't break up the sync, even if one of the notes in the sync belongs to the same voice as the inserted note. If any of the notes

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in a sync move, they should all move. (The justifier sometimes violates this rule, but only when it is obvious that the notes have been incorrectly synchronized.)

There are three ways of measuring the "time" of an event: as seconds from the start of play, as beats from the start of the score, and as inches from the first measure line. Although these notions of time are very different, they coexist nicely because the order of one is usually the order of the other. Thus, if note A is displayed to the left of note B, it is most likely played before note B. In general, we can use the order of the notes as they appear on the display to determine the order in which they should be played. There are a few exceptions that must be handled properly—embellishments such as trills and grace notes are not always played in the order in which they are displayed. Conversely, notes that are logically simultaneous may be separated slightly on the display in the interest of visual clarity.

Beams and chords are ancillary to the main data structure, because they act as horizontal and vertical parentheses grouping notes together; they are visual aids for the human performer and aren't otherwise crucial to the score. Removing all of the beams and chords from a score would affect its readability but not its playing. In Mockingbird, each beam and chord knows what notes belong to it, and each note knows what beam and chord it belongs to. In addition, chords have a stem direction and beams have a tilt and vertical position.

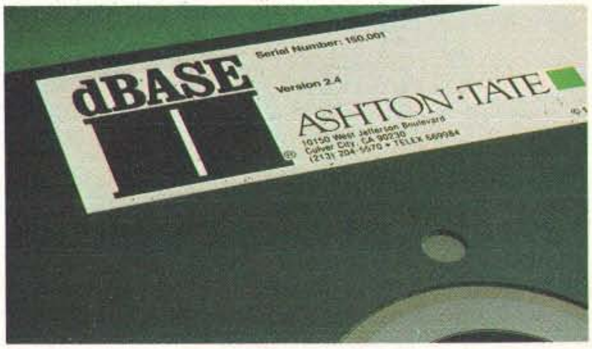
The linear data structure we have been discussing treats a score as a single, long sequence of measures, but because music is printed on rectangular sheets of paper, this sequence must be broken up into a succession of lines. Rather than complicate the main data structure, we use a separate data structure to map between the one-dimensional score and the two-dimensional sheet of paper. This sheet data structure keeps track of how long each line is, how many lines fit on each page, how much of the line must be devoted to a key signature, and which section of the score goes on which line. Only the displayer and the justifier need to make use of this representation of the sheet; all of the other algorithms manipulate the sequential data structure directly.

Automatic Recognition

We decided not to try to write a program that would attempt to deduce the score automatically from piano-roll input because we thought that job exceedingly difficult. Why? It has been done for some simple pieces; can it not be done more generally? We believe that the relevant question is: can it be done for polyphonic piano music where the voicing is not known in advance?

To produce a proper score you must, among other things, determine the time value of all notes. Although we traditionally think of "holding a note," say, for a quarter, we don't mean literally holding the key down. What is meant is that the next note (or rest) *in that voice* is to commence one quarter after the beginning of the note in question. Time values thus measure intervals rather than durations. (Although often the two are almost the same, in staccato playing it is not at all the case.) So, before you can assign time values to notes, you must first understand how the music is separated into its component voices. Voicing is partly dependent on thematic and harmonic relationships within the piece, but it may also be used by a composer simply to indicate how he wishes the music to be parsed by the reader, for emphasis or for division between the hands. Sometimes a single note may participate in two different voices, possibly even with two different time values. Rests and ties further complicate the problem, as they are elements that appear in the score to help complete rhythmic structuring, but they are absent from the actual playing.

The assignment of notes to staves forms a further structuring element in piano music. This assignment is a



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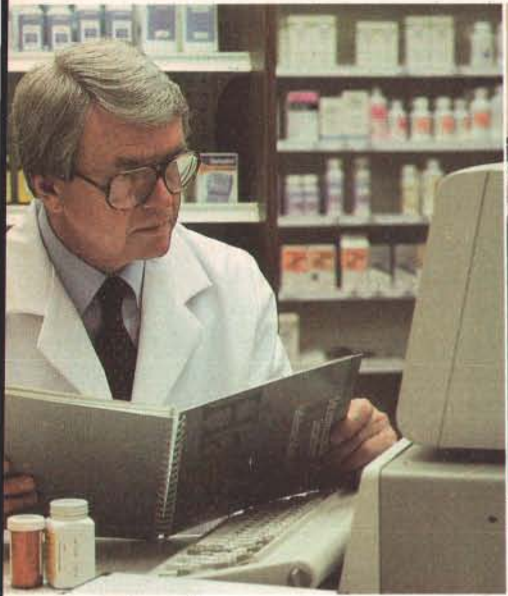

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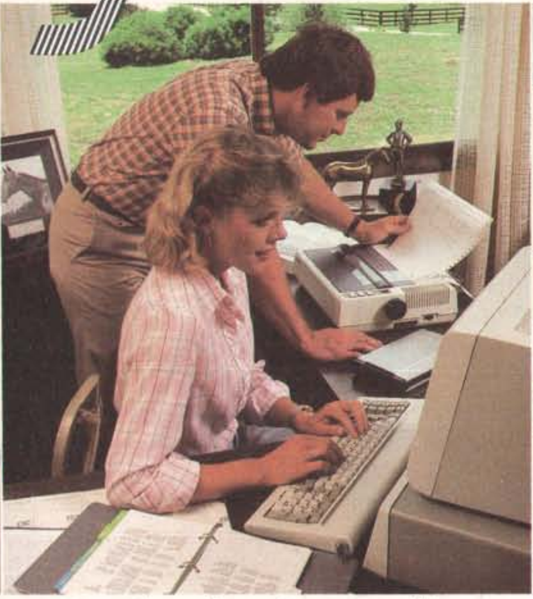

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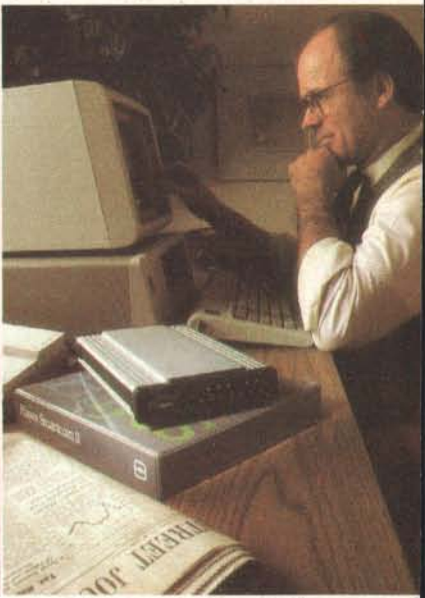

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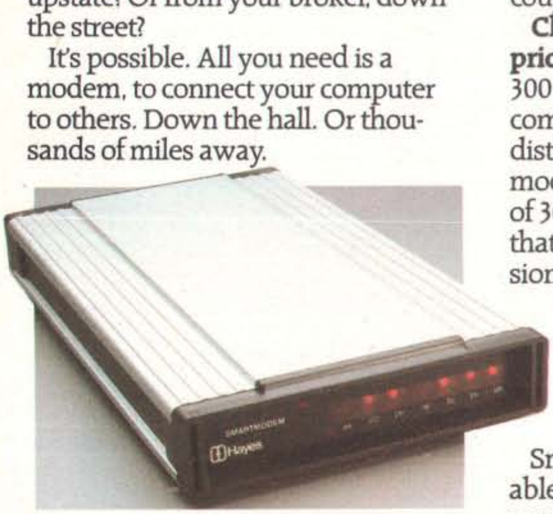

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complex function of voicing, fingering, division between hands, and aesthetic judgment. There are many other problems: identifying complex n-tuplets, distinguishing grace notes, determining rhythm and detecting rhythmic changes, identifying measure lines, determining how many staves to use, how to combine notes into beams, when to switch clefs or use ottava, and, in short, determining *all* of the complex structural-notational devices that composers use to render their music readable.

Conclusion

Our intention in presenting this material is to encourage others to pursue similar endeavors.. Music editing is already being done on home computers and, while it will be some years before machines as powerful as a Dorado are found in every living room, useful tools will become feasible soon—even on home machines of modest cost. It would seem that a display of reasonable resolution and a mouse (or some similarly convenient pointing device) are prerequisites. But if you avoid the temptation to make "pretty" scores and stick to providing a simple "cut and paste" editor of piano-roll material, then a reasonable composing tool should soon become practical. The problem of storage and retrieval of snatches of material and full pieces would have to be addressed, but this seems tractable.■

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Glossary

accidental - *the prefix sign indicating a note that is foreign to the current key*
beam - *a bar (or bars) joining the stems of a set of notes that together form a rhythmic unit; the number of bars also indicates the time values of the notes so joined*
chord - *a group of notes played simultaneously*
clef - *(e.g., treble or bass) a sign placed at the beginning of a musical staff to determine the positions of the notes*
fermata - *a sign indicating that a note should be held past its normal value*
grace note - *a quick, light note attached to another note*
metronome - *a machine that clicks at a steady beat and can be adjusted to desired speed*
mordent - *a single rapid alteration of a principal note with an auxiliary a half-step below*
n-tuplets - *n notes, played in one beat*
ottava - *a notation for designating a section of music to be played an octave above or below where it is written*
rest - *a sign indicating silence of the same duration as the note for which it stands*
staccato - *indicates a note played crisply, in a detached manner*
time signature - *numbers at left of staff that indicate the number of beats to a measure and the note value of each beat*
trill - *an ornament produced by the rapid alterations of two notes, a half-tone or a tone apart*

Acknowledgments

Mockingbird was made possible by a fortuitous convergence of people, interests, and facilities. The environment at Xerox PARC in general, and within the Computer Science Laboratory (CSL) in particular, provided a hospitable environment for this work. The existence of, and access to, a Dorado was absolutely essential. Robert W. Taylor, director of CSL, provided us with this and all other necessary facilities and support. Will Crowther worked closely with us on the initial design and helped us get started. John Warnock and Doug Wyatt provided us with the Cedar Graphics software package that Mockingbird uses. Gene McDaniel wrote special Dorado microcode for handling the synthesizer, and Mike Overton built the hardware interface. Last, and most gratifying of all, has been the enthusiastic support that we received from our colleagues, whose vicarious pleasure in seeing Mockingbird come to life cheered us along the way.

John Turner Maxwell III and Severo M. Ornstein can be reached at the Palo Alto Research Center, 3333 Coyote Hill Rd., Palo Alto, CA 94304.

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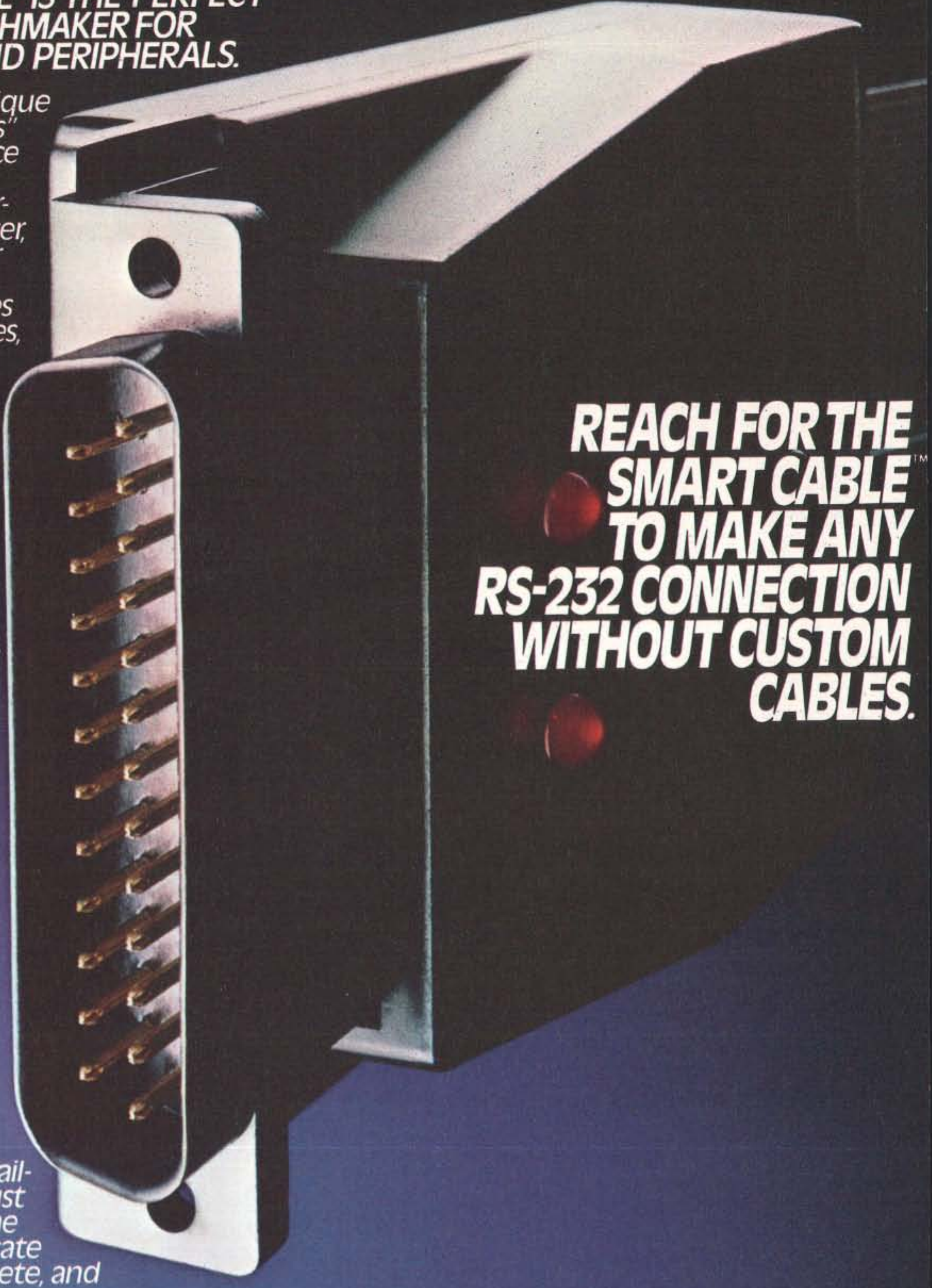
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The VU68K Single-Board Computer

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by Edward M. Carter and A. B. Bonds

As more and more 16-bit microprocessors appear on the market, the question of which one to base a development or hobbyist system on becomes more difficult. Ideally, most hobbyists and students would base their decision on thorough hands-on experience, but getting hold of inexpensive trainers is almost impossible. There is relief, however—the VU68K, a complete 68000-based single-board computer that can be constructed for under $200. The VU68K is not a toy but a powerful dual-ported computing engine that is limited only by its small memory, which can easily be expanded.

Hardware Description

We set out to design a simple and low-cost 16-bit microprocessor system that would offer maximum utility in both tutorial and development applications. Of the 16-bit processors that we examined, our overwhelming choice was the 68000, which offers both simplicity and substantial processing power. This power is evident in its comprehensive instruction set, which supports two processing modes and a powerful interrupt-processing facility (also called exception processing). A secondary, yet significant, benefit is the 68000's sales leadership. The VU68K system thus provides the user with marketable and timely knowledge. Additional reasons for selecting the 68000 include proven reliability and a commitment on the part of Motorola to maintain compatibility between its new chips and the 68000.

The 68000 uses "words" (the name for the instructions or data that the microprocessor operates on) of 16 bits or 2 bytes in "width." (Recall that an 8-bit microprocessor uses words of 8 bits in width.) We decided to include 2K words of ROM (read-only memory) with the VU68K for a monitor, and 2K words of RAM (random-access read/write memory) for developing and testing user programs. This gives the VU68K a total memory of 4K words in "length" and 16 bits in "width." In addition, we added two RS-232C-compatible serial ports for connection to a modem, a printer, or what have you.

We were able to include these features at very low cost. The parts list in table 1 shows prices from a major retail supplier of electronics parts. All of the parts are readily available and can be obtained from many sources. The prices shown are from a single catalog—a little bargain hunting would probably yield a much less expensive system. Note that the total cost of $190.22 is for a complete system built from scratch. It includes the costs of resistors, capacitors, wire, circuit board, etc. The cost of upgrading from an 8-bit computer to a VU68K configuration will be much less, assuming that the memories, circuit board, crystals, etc., from the old system can be retained.

Photo 1 and the schematic in figure 1 show how simple our design is. Only 15 ICs (integrated circuits) are required for the entire VU68K system. The functions of these 15 ICs can be divided into six categories: asynchronous bus operation, synchronous bus operation, interrupt handling, address decoding, communications interface, and miscellaneous support.

Asynchronous Bus Operation

The 68000 (IC2) is designed to communicate asynchronously on the system bus; that is, without a timing signal and with any amount of time between data bytes or words. To indicate when data has been received or sent, the device with which the 68000 is communicating sends an

← Circle 467 on inquiry card.

acknowledgment signal to the 68000. This way, the device and the 68000 can operate at different rates and still communicate with each other, because one waits for the other to finish reading or writing. (See the *Motorola MC68000 16-Bit Microprocessor User's Manual* for the details on 68000 asynchronous bus communication.)

In the VU68K, only the RAM (IC9, IC10) and ROM (IC7, IC8) communicate asynchronously on the data bus. Since the memories don't themselves have an acknowledgment signal, we synthesized one with a synchronous 4-bit counter (IC4) driven by a simple oscillator circuit and 5-MHz crystal. When the address strobe signal, $\overline{\text{AS}}$, goes low to signal a valid address on the address bus, an initial count of 1100 is loaded into the counter. After four clock ticks, the high-order output bit, connected to the acknowledge pin $\overline{\text{DTACK}}$ (data transfer acknowledge) goes low. The transition signals that the data requested by the processor is available

Text continued on page 411

IC	Part Number	Description	Cost ($)
1	7400	Quad 2-input NAND Gate	.19
2	68000G8	MPU 16-bit (8 MHz)	69.95
3	7404	Hex Inverter	.25
4	74161	Synchronous 4-bit Counter	.69
5	74154	4-to-16 Decoder	1.25
6	7432	Quad 2-input OR Gate	.29
7	2716	16K EPROM 450ns	4.95
8	2716	16K EPROM 450ns	4.95
9	6116-P4	Static RAM 200ns 16K CMOS	6.95
10	6116-P4	Static RAM 200ns 16K CMOS	6.95
11	6850	Async. Comm. Int. Adapter	4.95
12	6850	Async. Comm. Int. Adapter	4.95
13	14411	Bit-rate Freq. Generator	11.95
14	1488	Quad Line Driver	.69
15	1489	Quad Line Receiver	.69
—	8800V	Vector Board	24.95
—	7812	12-volt Positive Regulator	.79
—	7912	12-volt Negative Regulator	.89
—	—	5 MHz Crystal	2.95
—	—	1.8432 MHz Crystal	4.95
—	—	Capacitors, Resistors, Wire	4.25
—	—	Pushbutton Switch	1.95
—	—	8-position DIP Switch	1.49
—	—	14-pin Wire-wrap Socket	5 @ .45
—	—	16-pin Wire-wrap Socket	2 @ .69
—	—	24-pin Wire-wrap Socket	8 @ 1.29
—	—	64-pin Wire-wrap Socket	14.40

Table 1: *Parts list.*

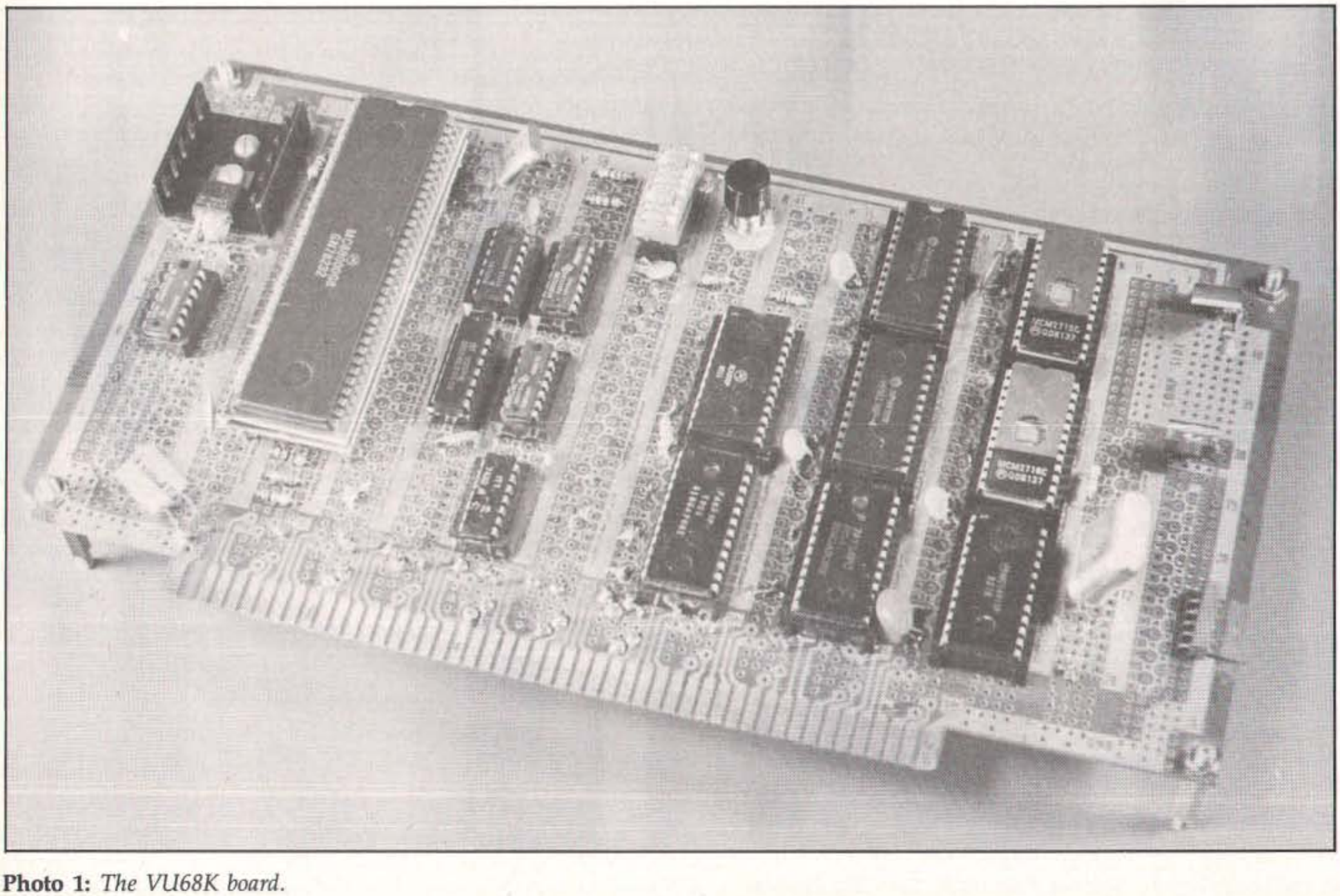

Photo 1: *The VU68K board.*

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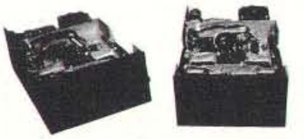

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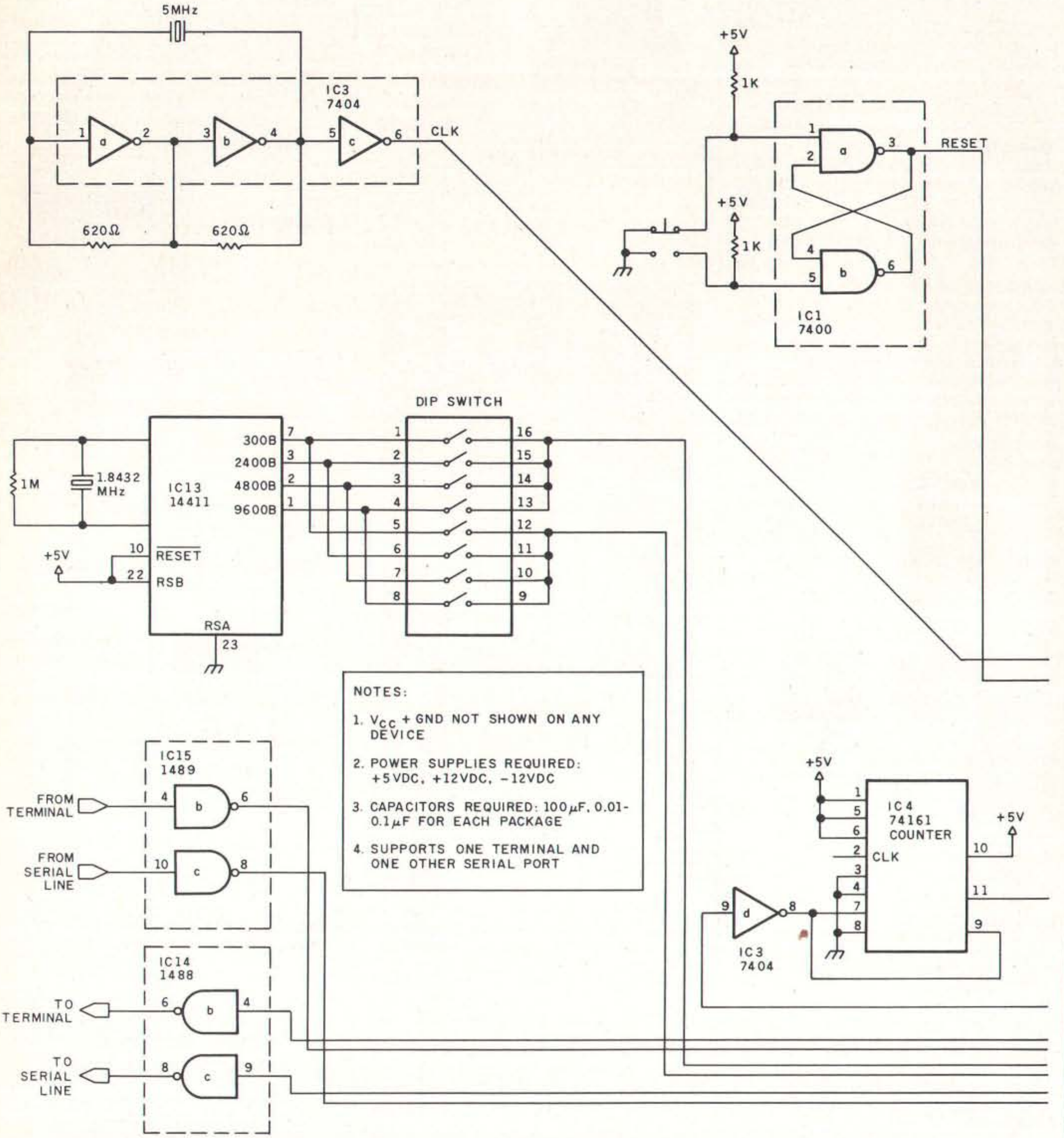

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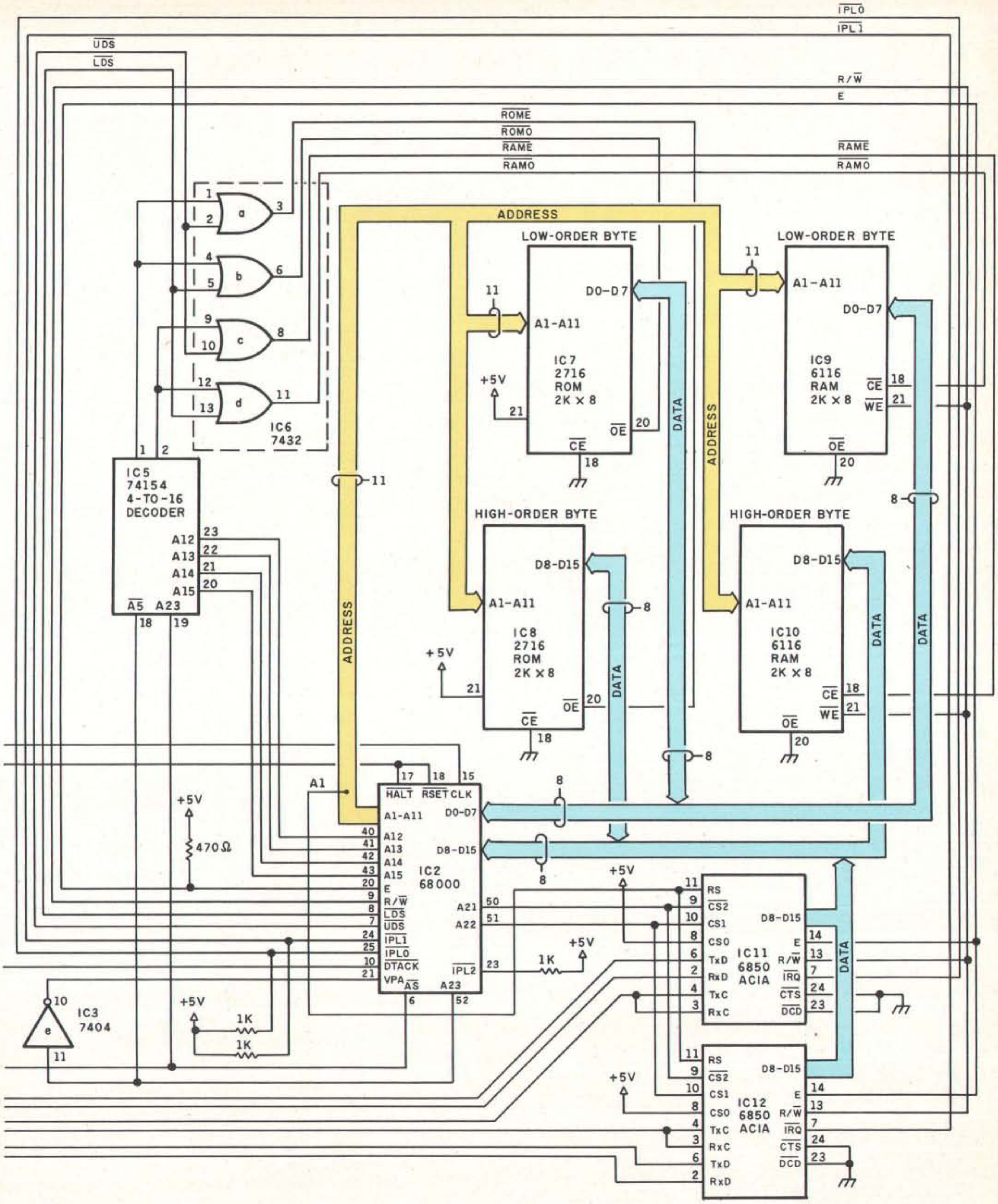
Figure 1: *The VU68K schematic.*



IPL0
IPL1
UDS
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R/W
E
ROME
ROMO
RAME
RAMO
RAME
RAMO
ADDRESS
LOW-ORDER BYTE
LOW-ORDER BYTE
a
b
c
d
IC6
7432
IC5
74154
4-TO-16
DECODER
A12
A13
A14
A15
A5
A23
A1-A11
D0-D7
IC7
2716
ROM
2K × 8
+5V
OE
CE
DATA
ADDRESS
A1-A11
D0-D7
IC9
6116
RAM
2K × 8
CE
WE
OE
HIGH-ORDER BYTE
HIGH-ORDER BYTE
D8-D15
A1-A11
IC8
2716
ROM
2K × 8
+5V
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D8-D15
A1-A11
IC10
6116
RAM
2K × 8
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DATA
A1
HALT
RSET
CLK
A1-A11
D0-D7
D8-D15
A12
A13
A14
A15
E
R/W
LDS
UDS
IPL1
IPL0
DTACK
VPA
AS
A23
A21
A22
IPL2
IC2
68000
+5V
470Ω
1K
+5V
1K
1K
+5V
IC3
7404
e
RS
CS2
CS1
CS0
TxD
RxD
TxC
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D8-D15
E
R/W
IRQ
CTS
DCD
IC11
6850
ACIA
DATA
+5V
RS
CS2
CS1
CS0
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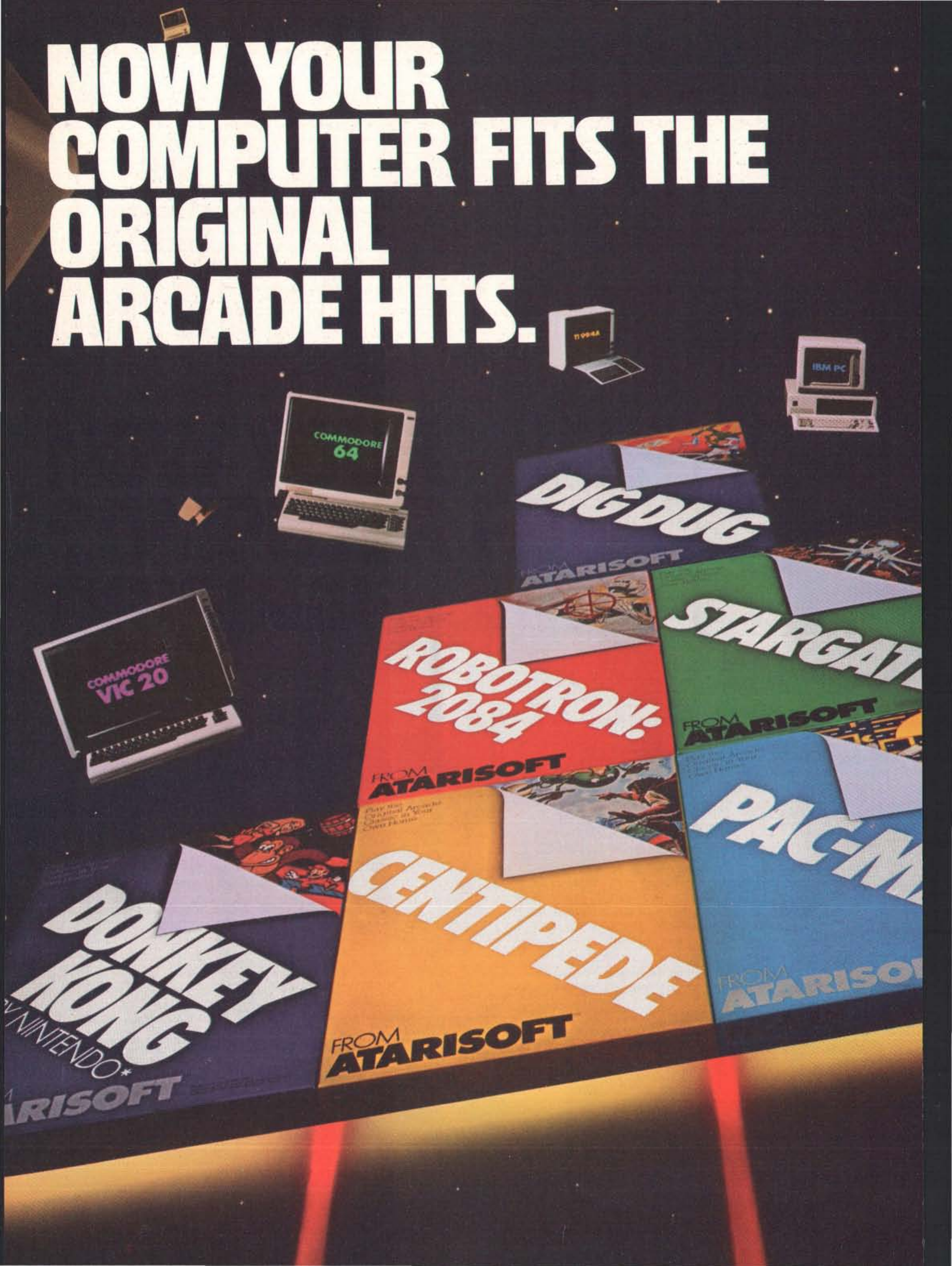
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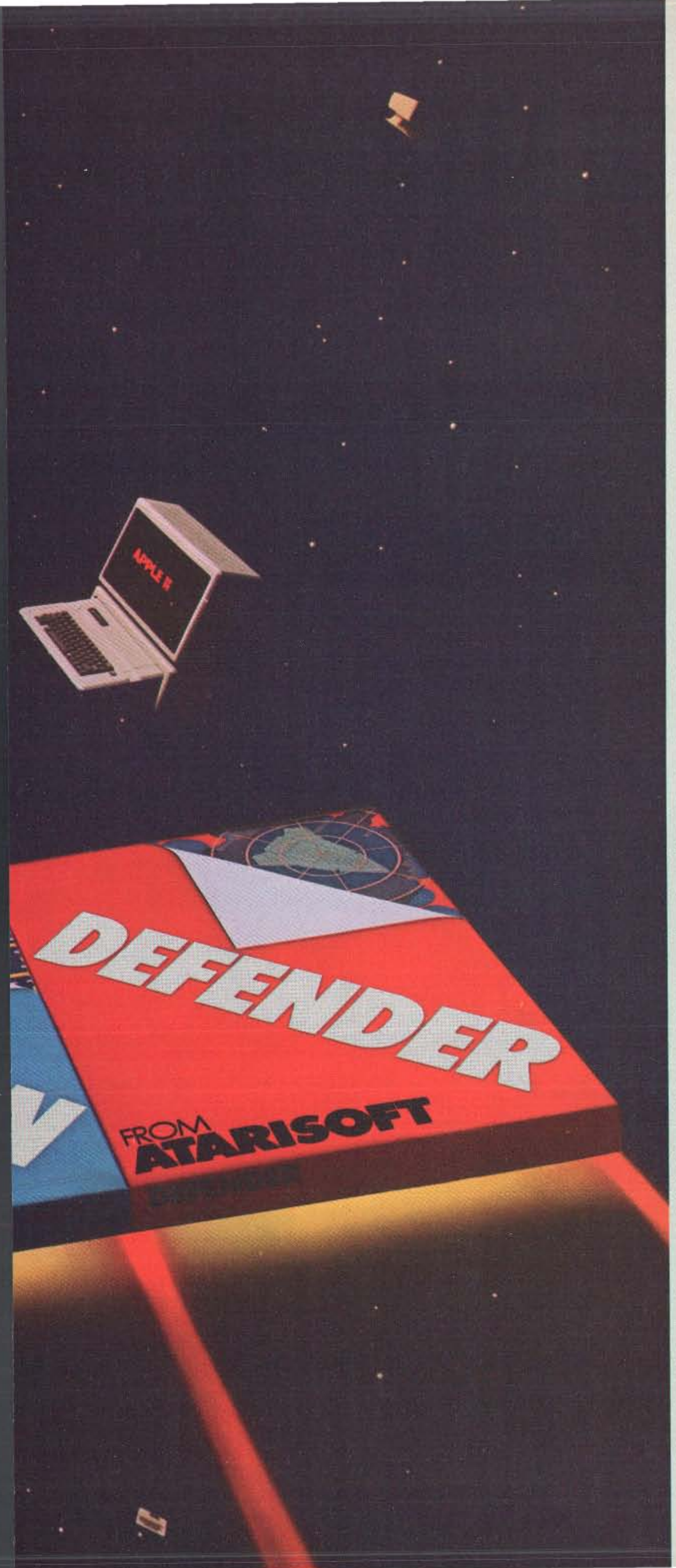

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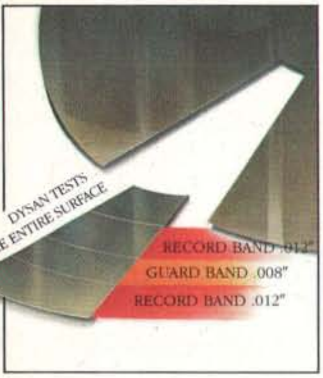

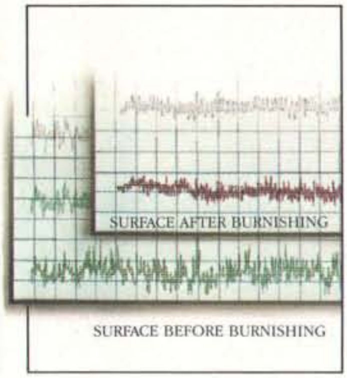

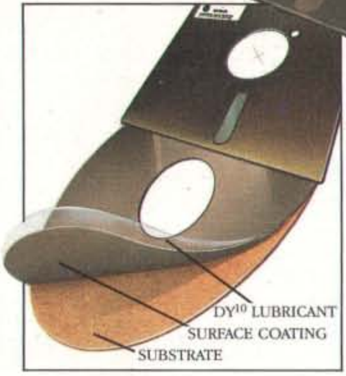

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Text continued from page 404:

on the bus. With a clock speed of 5 MHz, this provides 800 nanoseconds (ns) for the transfer to occur.

Synchronous Bus Operation

In the design of the 68000, Motorola recognized that a large number of 8-bit synchronous peripherals are available and familiar to many people. These devices depend on the timing signals generated by the 6800 family of processors for data communication. To provide compatibility, the 68000 can also generate a synchronous timing signal.

When the AS line is asserted (low), the synchronous peripherals must pull the VPA (valid peripheral address) processor pin low to generate the synchronous timing signals VMA (valid memory address) and E (enable). In the VU68K, the only set of devices that uses synchronous transfers is the Asynchronous Communications Interface Adapters or ACIAs (IC11, IC12), which drive the two serial ports (note that the term asynchronous here refers to the RS-232C standard and not the bus protocol). These two ports may be accessed at addresses $A00000–$A00002 and $C00000–$C00002. (For the remainder of this article, the prefix "$" will denote a hexadecimal address.) Address line A23 is tied to the processor's VPA pin through an inverter (IC3). When either ACIA is selected, A23 must be high, which pulls VPA low and initiates the synchronous data transfer. After the transfer is complete, the processor automatically resumes asynchronous operation. This scheme limits addresses using A23 to synchronous devices only.

Interrupt Handling

The 68000 has two modes of interrupt processing: normal and alternate. In the normal mode, the processor responds to an interrupt request by placing the level number of the interrupt on bits A1–A3 of the address bus and driving the function code lines FC0–FC2 high. The interrupting device then must place a vector number on the data bus and pull DTACK low to signal the 68000 that the vector number is available. The 68000 uses this vector number to acquire the service-routine address from the vector table in low memory. In the alternate mode, known as auto-vectoring, the processor again places the level number of the interrupt on A1–A3 and drives FC0–FC2 high. Then, instead of placing a vector number on the data bus, the interrupting device pulls the VPA processor pin low. This causes the processor to acquire the service-routine address from the position in the vector table that corresponds to the interrupt level. Therefore, in auto-vector mode, there are seven interrupt vectors, each of which is associated with one level of interrupt.

Address	Device
$000000–$000FFF	ROM
$001000–$001FFF	RAM
$A00000–$A00002	Terminal
$C00000–$C00002	Serial Port

Table 2: *The address map.*

The VU68K uses the auto-vector mode for interrupts. When the 68000 responds to an interrupt, all address bus lines except A1–A3 are driven high. Since A23 is connected to VPA through an inverter to support synchronous transfers, the processor is forced into the auto-vector mode for all interrupts.

The VU68K acknowledges only two levels of interrupt: level 1 for keyboard serial-port interrupts and level 2 for communication serial-port interrupts. Interrupts are signaled by lines IPL0 and IPL1. IPL2 is always maintained high. This interrupt structure enables the keyboard and communication serial ports to be used simultaneously.

Address Decoding

The VU68K's memory is divided into 2K-word by 16-bit memory blocks, with a total potential of 32K words. The reason for this arrangement is that the VU68K uses only 11 of the 68000's address bits for word selection and another 4 address bits for memory-block selection. The 11 bits select one of 2K words, while the other 4 bits select one of sixteen 2K-word blocks. Since each block contains 2K words, the total memory capacity is 2K by 16 or 32K words.

The word-selection bits, A1–A11, go directly to each of the ROM and RAM ICs. The block-selection bits, A12–A15, go to a 4-to-16 decoder (IC5). The decoder, through the IC6 OR gates, pulls the output enable (OE) lines of the selected 2K-word block low to activate that block. Since the data bus on the 68000 is 16 bits wide and the memory ICs used in the VU68K are each 8 bits wide, we had to use two memory ICs for each 16-bit-wide memory block. One of the memory ICs is assigned to the high-order 8 bits of the data bus, while the other is assigned to the low-order 8 bits.

The VU68K uses the 68000's UDS and LDS lines to control the method by which data is transferred to or from memory. If both lines are low, then data transfers occur in 16-bit words. If only one of the lines is low, then transfers occur one byte at a time. Note that two memory chips are active for a 16-bit transfer, while only one chip is selected for an 8-bit transfer. To select the correct device for a memory transfer, the output of the decoder is combined through an OR gate with the UDS and LDS signal to generate four signals—RAME, RAMO, ROME, ROMO—for selecting the correct memory device. The address map is shown in table 2.

To add memory or other asynchronous devices to the VU68K, all we have to do is select an address in the lower 64K bytes of memory. The high-order 4 bits of this new address cause one pin of the address decoder to be driven low. The output from this pin can then be used with additional decoding logic for selecting the new device. Adding a new asynchronous peripheral is even easier. Just select an address that sets address bit A23 and is not used by any other device. Addresses that set bit A23 are in the range $800000–$FFFFFF.

Let's assume that we wish to add another 2K-word block. We'll place two 6116 static RAM chips, 2K by 8 bits each, at addresses $002000–$002FFF. From the address map in table 2 we can see that these locations are not currently used. The new RAM select line will be pin 3 of the address decoder output. Two additional OR gates will be required to ensure that the device assigned to the upper and lower portion of the bus is addressed only when dictated by the appropriate setting of $\overline{UDS}$ and $\overline{LDS}$. The address map in table 3 represents the new configuration.

If we want to add a new synchronous device, the address extension is even simpler. Let's assume that we wish to add another serial port. The Motorola 6850 we used earlier is a serial port chip that requires three chip selects, two in the high state and one in the low state. If we tie one of these to a high state and then use the other two select lines, we can safely use addresses \$900000–\$900002 for the device's control/status and data registers, respectively. This address avoids conflict with the other two synchronous devices and allows us to drive the device select lines without additional logic. The high select line will be address line A20, and the low select line will be address line A21. Table 4 is an address map that includes the new memory and serial port.

To enhance the interrupt structure so that not all interrupts are handled in the auto-vector mode, make sure that the synchronous mode-select line is still driven high when the terminal and serial ports are addressed. Discrete logic can easily remedy this problem.

Address	Device
\$000000–\$000FFF	ROM
\$001000–\$001FFF	RAM
\$002000–\$002FFF	New RAM
\$A00000–\$A00002	Terminal
\$C00000–\$C00002	Serial Port

Table 3: *The extended address map.*

Address	Device
\$000000–\$000FFF	ROM
\$001000–\$001FFF	RAM
\$002000–\$002FFF	New RAM
\$900000–\$900002	New Serial Port
\$A00000–\$A00002	Terminal
\$C00000–\$C00002	Serial Port

Table 4: *The extended address map with a serial port added.*

Vector Address	Interrupt
\$1000	User Trap-vector B
\$1004	User Trap-vector C
\$1008	User Trap-vector D
\$100C	User Trap-vector E
\$1010	User Trap-vector F
\$1014	User Interrupt-vector 1
\$1018	User Interrupt-vector 2
\$101C	User Interrupt-vector 3
\$1020	User Interrupt-vector 4
\$1024	User Interrupt-vector 5
\$1028	Auto-vector Level 3
\$102C	Auto-vector Level 4
\$1030	Auto-vector Level 5
\$1034	Auto-vector Level 6
\$1038	Auto-vector Level 7

Table 5: *User interrupt-vectors.*

Communications Interface

The basis of the VU68K's communication facility is the ACIA. This 8-bit device communicates synchronously on the data bus and asynchronously on the external RS-232C line. Both ACIA devices in the VU68K are initialized by the monitor software to handle full-duplex RS-232C lines with two stop bits and no parity. You can change these characteristics by moving new values to the terminal and serial port control registers at locations \$A00000 and \$C00000, respectively. The values to be loaded there can be determined from the Motorola 6850 data sheet.

We added two line conditioners after the ACIAs to provide RS-232C logic levels to the external lines. We used 1488 and 1489 quad line-drivers/receivers (IC14, IC15) for this purpose. A 14411 bit-rate frequency generator (IC13) and a 1.8432-MHz crystal tell the ACIAs at what data rate they may transmit and receive on the RS-232C lines. Data rates are switch selectable through a dual inline package (DIP) switch and may be selected independently for either the terminal or communication serial port. The allowable data rates are 300, 1200, 2400, and 9600 bps. You can use other data rates by connecting the DIP switch to the proper pins on the 14411. All interrupts generated by the terminal or communication serial port are handled by the interrupt-service routines in the monitor, which we will describe later.

Miscellaneous Support

The only devices we haven't yet covered are the reset and clock circuits. The reset circuit is simply a debounced switch that pulls both the $\overline{RESET}$ and $\overline{HALT}$ pins of the processor low. These pins must be held low for at least 100 milliseconds for the reset operation to function correctly. In the VU68K, we used a push-on/push-off switch to do this. You can use a conventional momentary contact switch if you ensure that the switch is off for at least 100 milliseconds.

The clock circuit is an oscillator circuit driven by a 5-MHz crystal. The resulting signal, CLK, drives both the processor clock and the counter used in asynchronous accesses.

A Monitor Program

To support the hardware of the VU68K, we developed a comprehensive monitor program called VUBUG. VUBUG provides a set of program-development support services that includes I/O (input/output) buffering, program-development commands, trap handlers, and error-handling utilities.

VUBUG provides buffered I/O for both the terminal and communication serial port. Separate interrupt-handling routines for these devices located at level 1 and level 2 of the interrupt structure, respectively, provide a complete set of facilities for implementing concurrent buffered I/O. When a port generates an interrupt, VUBUG causes the processor to read the port and place the data in a buffer that can store 16 bytes. A trap instruction, which we will discuss later, retrieves the data. Interrupts from the terminal keyboard cause the character read to be echoed immediately as well as buffered.

The VUBUG interrupt structure includes five auto-vectors, the first five user interrupt-vectors, and five user trap-vectors, which are loaded by the monitor to point to the locations shown in table 5. At each of these

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locations, you may assemble a branch instruction to an exception handler that you provide. The 4 bytes set aside for each vector allows for a branch with a 16-bit displacement. Be careful to terminate these exception handlers with an RTE instruction to ensure proper return from the exception handler.

VUBUG supports a set of commands that we've selected to support the goal of simplicity. Table 6 summarizes the available commands and subcommands. Perhaps the most powerful command for program development is a combination of the Trace (t+) and Breakpoint (b+) commands. Trace is an instruction-by-instruction trace of the value of the user program counter; it shows the

Command	Action
m<cr>	Start memory mode
m xxxx	Start memory mode at xxxx
.xxxx	Set pointer to xxxx
=xx	Store value xx at address in pointer
,xx	Increment pointer and store xx
+	Increment pointer and display value
–	Decrement pointer and display value
l<cr>	Start program load
l xxxx	Start program load and offset each block by xxxx bytes
d<cr>	Display the next 80 bytes from memory pointer
d xxxx<cr>	Display 80 bytes starting at address xxxx
d xxxx,yyyy	Display all data between locations xxxx and yyyy inclusive
t+	Start trace
t–	Stop trace
s+	Start single step
s–	Stop single step
e	Start terminal emulator mode
g xxxx	Start program at address xxxx
g<cr>	Start user program from address in user PC
<cr>	Same as g<cr>
b+xxxx	Insert a breakpoint at address xxxx
b–xxxx	Remove a breakpoint at address xxxx
b<cr>	Show all breakpoints
b#	Remove all breakpoints
r<cr>	Start register mode
r xx	Start register mode at register xx where xx is: SR/sr status register PC/pc program counter D0/d0 –D7/d7 data registers A0/a0 – A7/a7 address registers
.xx	Set register pointer to register xx
=xxxxxxxx	Store value in register at pointer for SR value is xxxx
<cr>	Print values in all registers
px yyyy	Associate with px the program starting at address yyyy; where x is 1, 2, or 3
px<cr>	Execute command px where x is 1, 2, or 3
c xxxx=yyyy,zzzz	Copy from location yyyy through location zzzz to locations starting at xxxx and increasing

Table 6: *Command summary.*

Trap	Function	Place Argument in Register	Return Argument is Placed in Register
0	Exit	None	None
1	Get byte	None	D0
2	Get word	None	D0
3	Get long	None	D0
4	Write byte	D0	None
5	Write word	D0	None
6	Write long	D0	None
7	Get character	None	D0
8	Write string	A0	None
9	Write character	D0	None
A	Write cr-lf	None	None

Table 7: *VUBUG traps.*

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- ☐ IDRIS[3] O/S with C, PASCAL, FORTRAN 77, 68K-BASIC[1], CIS COBOL[4], INFORMIX[5] Relational DBMS
- ☐ UNIX[6] SYS III O/S with C, PASCAL, FORTRAN 77, BASIC, RM COBOL[7], ADA[8], INFORMIX[5], Relational DBMS
- ☐ VED 68K Screen Editor
- ☐ Motorola's MACSBUG and FFP Package

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program's execution path. Breakpoint stops the program at the address you select. With these two commands, a user may see the instructions leading to a breakpoint and then use the other commands available in VUBUG to examine registers and memory to determine why that path was taken or to modify the path that will be taken after the breakpoint.

The VUBUG monitor provides 11 traps for servicing user-program requests. These traps are called simply by executing the appropriate trap instruction with the appropriate argument, as shown in table 7. In addition to these trap handlers, you can use traps B through F with the vectors at locations shown in table 5.

Error handling, or exception processing, for processor-detected errors, is also provided by VUBUG. Error handling involves intercepting the interrupt and reporting the error on the terminal. In addition, the register values are copied into the register save area and are accessible via the r command. The errors trapped include address/bus errors, illegal instruction errors, privilege violations, and a class of generic errors that share a single error handler. The errors in this class are zero divide, CHK and TRAPV, and spurious interrupts.

Rounding Out

For a complete development system, you'll need an RS-232C terminal, a power supply that provides +5 volts at 0.5 amperes, and +12 and −12 volts at 0.1 amperes, and a host computer.

Development software on the host should include a disassembler, high-level language processors, cross-reference builders, machine simulators, and so forth. The only additional software required is a simple program to send the object program to the serial port for loading. Only your imagination and the capabilities of the host limit its use.■

This system is currently running at Vanderbilt University and is proving to be an easy method for designing and testing software to run on the VU68K. Readers who desire more information on the VU68K and VUBUG can, for a nominal fee, order a copy of Vanderbilt University Computer Science Technical Report CS-83-01 from the following address:

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The authors would like to thank the Computer Science and Electrical Engineering departments of Vanderbilt University for their support in VU68K system design and realization. Special thanks to Motorola Corporation for its assistance in the hardware design.

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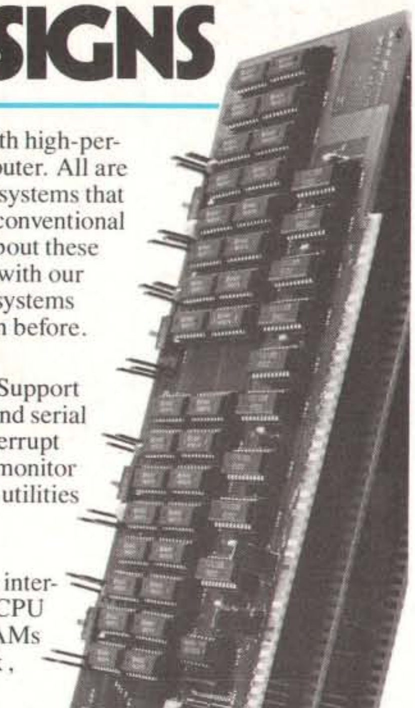

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Translating the SAS Language into BASIC

Use of a preprocessor program lets you run SAS-like syntax on microcomputers

by Jeff Bass

This article examines issues that arose when I implemented a preprocessor program to translate SAS-like program statements to statements in version 5 of Microsoft BASIC. It is easier to use a preprocessor program than to write a true SAS compiler for a microcomputer because the source and object languages of Microsoft BASIC's version 5 used with a preprocessor are more similar to each other than to those a compiler would utilize. An overview of SAS appears in the text box on page 433 and provides an introduction to the language.

Special SAS Features

Unlike SAS, traditional programming languages require the development of a data structure for each file as well as a data structure for all program variables and algorithms for manipulating these elements. SAS syntax, however, allows a programmer to take advantage of an invisible data file structure (the SAS data set) and a means of relating that structure to the program variables. In SAS programs that deal with a data set, all variables are referred to by an eight-character name, without regard to such factors as column positions. SAS also provides a large library of programs that interact directly with this standard data structure. These features, which make SAS popular for use on mainframes, also make its syntax attractive for use on microcomputers; the size of its program library has thus far, however, prohibited the language's use on microcomputers.

The most commonly used language for microcomputers is BASIC. It's a primitive language compared to full SAS syntax, but small and easy enough to implement as an interpreter. Thus, it is almost universally used on microcomputers, where it's stored in ROM and therefore easily accessible. Kernighan and Plaugher in *Software Tools* (Reading, MA: Addison-Wesley, 1976) demonstrate how to deal with the problem of working with a less-than-optimum yet readily available language, such as BASIC, when you would prefer to work with another (SAS, for example). They show how to use a program called a preprocessor to translate RATFOR program statements, which they like to use, into a program composed of FORTRAN statements, which would be usable on their machine.

I have written a preprocessor program that similarly translates SAS-like program statements into equivalent BASIC statements and thus permits SAS-like programs to run on a microcomputer. The preprocessor approach, combined with the interpretive nature of BASIC, makes the resultant programs run slowly, but it has nevertheless proved practical for small programs and data sets. Researchers should find such a preprocessor useful with a relatively small data set—for instance, one with 200 to 300 observations of 30 variables. Such a preprocessor also could be used in teaching computer skills with microcomputers.

The remainder of this article examines the choice of a SAS-syntax subset, the strong and weak points of the BASIC dialect used, the method chosen for representing data, and preprocessor techniques employed. It concludes with a suggestion for an area to explore in the future.

SAS Syntax Features

The SAS syntax is very similar to that of PL/I in format and scope. Therefore, writing a preprocessor program that would implement the entire language on a microcomputer seemed impossible. I had to make

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some difficult choices: what was too important to leave out, and which processes were too long to keep? SAS processes, abbreviated as procs, operate as subroutines, although they are actually primitives of the language. A few candidates were eliminated: Proc Matrix, which requires that all matrices be held in memory, and Proc Sysreg, which requires that large sigma matrices be stored in memory. In addition, Proc BMDP (biomedical data processing) was eliminated because it wasn't available for use on microcomputers, and Proc Convert was not used because the types of data sets it converts would not be found on a microcomputer. Operating-system utilities that would not be useful on a microcomputer were also left out.

Even with these processes omitted, far too many remained for one person to code in a reasonable amount of time, so I decided to concentrate on the 10 I use most frequently: SORT, PRINT, CONTENTS, COPY, CORR, DELETE, MEANS, FREQ, GLM (general linear models procedure), and PLOT. Any two SAS users would probably argue about the wisdom of these choices, but these procs did provide a reasonable place to begin.

Each process would become a BASIC program, chained (executed in sequence) from the preceding BASIC program corresponding to a process or data step. Subsetting the data step proved difficult; however, one goal was sufficiently important to dominate the procedure: MAS (microcomputer analysis system) should be a *true* subset of the commonly accepted SAS syntax, thus making it unnecessary for users to learn another syntax. To be a true subset, it would have to maintain the original SAS syntax and spelling; deletion of features would be the only acceptable change.

This decision made it easy to drop features of the data step that would be the most difficult to implement on a microcomputer, such as those formats usable on mainframes. Because data sets used on a microcomputer are likely to have been typed in by the user (or to be sufficiently small to permit a user to type them), a profusion of formats for dealing with widely varied data is less useful on a microcomputer than it would be on a mainframe. Therefore, I decided to limit raw data input to list input and to eliminate formats from raw data as well. Also, because of their implementation and limited usefulness in small data sets, the ARRAY statement and its associated DO OVER statement were also left out. Most of the remaining data-step statements were implemented.

Special Features of BASIC Version 5

Using even a complex preprocessor to translate SAS syntax to an ordinary or standard dialect of BASIC was extremely difficult. I chose the most common version of BASIC used on microcomputers, Microsoft, which is used on many 8- and 16-bit machines. Versions of Microsoft BASIC are also the built-in language of Apple, IBM, and other popular microcomputers. In addition, BASIC is available for computers that run CP/M-86.

SAS's syntax resembles that of PL/I in scope and format.

The current release from Microsoft, version 5, is more than an extended dialect of BASIC, however. It is nearly a complete operating system, performing many of the functions that JCL (job control language) provides for the mainframe SAS package, including creating, deleting, and renaming disk data sets and chaining programs. This release also allows common variables and files between such chained programs. In addition, Microsoft BASIC permits IF. . .THEN . . .ELSE constructs and such structured control statements as WHILE . . .WEND (equivalent to SAS 82's DO. . .WHILE. . .END statement). Moreover, it permits double-precision calculations, 40-character variable names, and character variables with as many as 255 characters. Version 5's most important feature, however, is its ability to write BASIC program text to a disk file and then execute that

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file—exactly what is needed for a SAS syntax processor.

But this version of BASIC presents problems as well as solutions. For example, it permits only as many as 15 files to be opened at one time. And because five files are required for such functions as keeping an event log and printing output, only 10 data sets remain accessible to processes and data steps. Moreover, because Microsoft BASIC is an interpreted language, each line of BASIC code is translated every time it is encountered during program execution. This can make programs run much more slowly than programs compiled into native machine code. And although Microsoft does offer a BASIC compiler that uses a language similar to the one its interpreter offers, it would be difficult to use in the preprocessor arrangement described here because it loses the ability to dynamically dimension arrays and loses some of the chaining capability provided by the interpreted BASIC.

Despite these drawbacks, however, BASIC provides features that make it a good choice for SAS syntax translation. First, it provides many functions that are identical or very similar to those used in SAS data-step programs; table 1 lists some examples. Second, like SAS, it computes the result of a logical comparison as a numeric quantity that can then be used in subsequent calculations. Consequently, an expression that categorizes variables, such as

```
CAT_AGE (AGE<16)*1 +
(AGE>=16 AND AGE <65)*2 +
(AGE<=65)*3
```

will work in a BASIC program just as it does in a SAS program, with the following exception. In BASIC programs, the result of a logical comparison is equal to −1 if true and 0 if false; in SAS programs, those results would be +1 if true and 0 if false. The preprocessor could include code to reverse the sign of all relational expressions. In the current version, however, I chose not to include it. BASIC also uses fairly understandable error messages, such as "file not found" or "attempt to divide by 0,"

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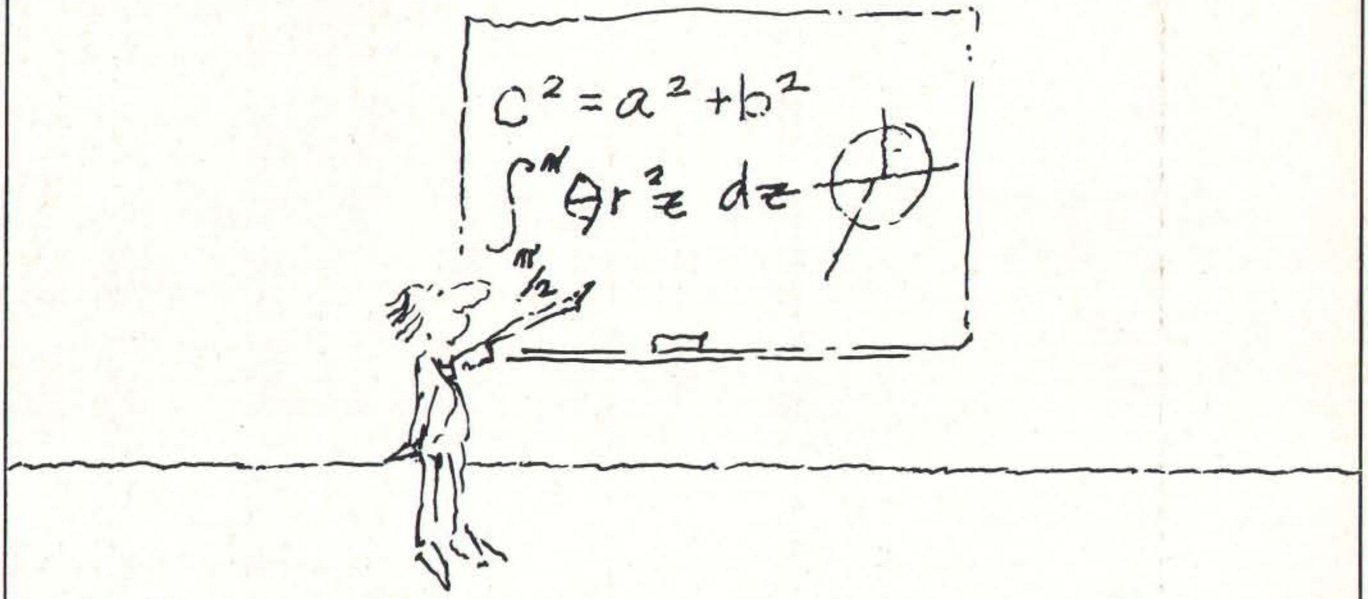
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SAS function . . . . becomes	. . . . Microsoft BASIC function
SUBSTR(charvar,startpos,len)	MID$(charvar,startpos,len)
INPUT(charvar,fmt)	VAL(charvar)
PUT(charvar,fmt)	STR$(charvar)
LENGTH(charvar)	LEN(charvar)
ABS(numvar)	ABS(numvar)
FLOOR(numvar)	INT(numvar)
INT(numvar)	FIX(numvar)
SQRT(numvar)	SQR(numvar)
SIN(numvar)	SIN(numvar)
ATAN(numvar)	ATN(numvar)
ARSIN(numvar)	FNARSIN(numvar)
	with DEF FNARSIN(x)=ATN(x/SQR(1−x*x))
COSH(numvar)	FNCOSH(numvar)
	with DEF FNCOSH(x)=(EXP(x)+EXP(−x))/2
EXP(numvar)	EXP(numvar)
LOG(numvar)	LOG(numvar)
ROUND(numvar,places)	FNROUND(numvar,places)
	with DEF FNROUND(x,y)=FIX(x/y+.5)*y
SIGN(numvar)	SGN(numvar)
UNIFORM(numvar)	RND
	with RANDOMIZE(numvar)

Note: *A BASIC statement following the word "with" is executed one time during program initialization.*

Table 1: *Because SAS and BASIC functions are similar, translating between the two languages is simple, as these examples illustrate.*

and allows a programmer to trap errors, handle them, and resume program execution. Thus, a SAS syntax preprocessor can rely heavily on the error-trapping capability of the interpreter, greatly simplifying its design.

In addition, this version of BASIC allows the dynamic loading of machine-code programs and permits calling them as subroutines. Thus, many operations, such as sorting or inverting a matrix, which suffer from the interpreter's slowness, can be compiled into machine-code subroutines that are loaded and called as needed by the preprocessed SAS program—from an interpretive BASIC environment.

File Structure and Treatment of Missing Values

Before the processor was designed, two important system features had to be carefully specified: the file structure for system data sets residing on the microcomputer disk and the representation of missing values. Both greatly affect the code to be generated by the preprocessor. A question of compatibility immediately arose—should the MAS file structure be designed to imitate the SAS data set structure? And should its missing value representation be the same? Careful study of these questions led to an answer of "no" to both.

SAS system files will never be transferable between mainframes and microcomputers using a BASIC preprocessor approach, because the two systems use drastically different methods for internal binary representation of numbers. Moreover, IBM mainframes use a coding scheme for text, EBCDIC (extended binary-coded-decimal interchange code), that differs from the one most commonly used on microcomputers, ASCII (American National Standard Code for Information Interchange).

After direct compatibility was ruled out, a clean slate remained for file design. The file design chosen was arbitrary, and virtually any one would work, provided it had been

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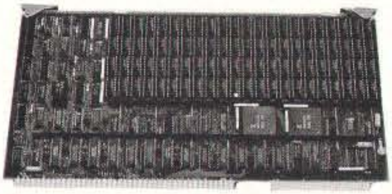

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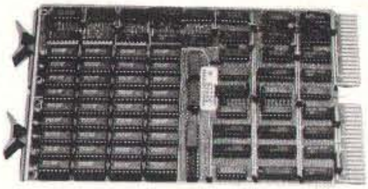

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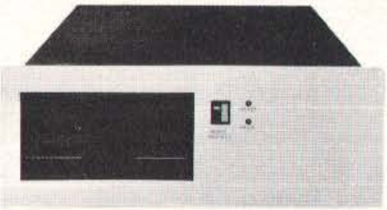

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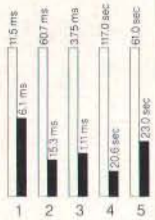

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consistently implemented in the data step and all proc steps, which call on a SAS procedure to perform a particular task on specified variables in a SAS data set. Because microcomputer files cannot easily span multiple disks, the disk was regarded as part of a microcomputer's, similar to the operating-system data set on a mainframe. One disk would correspond to one MAS database.

In the interest of simplicity, only one-part data-set names were implemented; responsibility for disk management was left to the user. Each named MAS data set generates two microcomputer disk files, which are also identified by their MAS data-set name. One file has the suffix .HDR (for header) and contains file-header information such as filenames and variable names, types, lengths, and labels. The other file has the suffix .DAT (for data) and holds the data-set data.

I performed timing tests to determine whether numeric data should be represented in binary or ASCII form. Although Microsoft BASIC permits both types, the ASCII form is much simpler to program. The tests showed that the binary form was worth the extra effort, however, because it permits files, especially those with noninteger numbers, to be read in half the time that the ASCII form does. The .DAT files therefore store numeric variables in internal binary form and character strings in ASCII representation. Block size is determined by the disk-sector size of the microcomputer used.

Missing values also presented complex choices. In the SAS package for use on mainframes, missing values behave in comparisons as though they had a value of negative infinity, and if they are used on the right-hand side of a numeric expression, they propagate to the left-hand side. Furthermore, if an illegal mathematical operation is performed, a missing value is also assigned to the left-hand side. In a microcomputer emulation, therefore, the method of representing missing values chosen should be easily recognized and also have these properties. I decided to use the 8-byte binary representation

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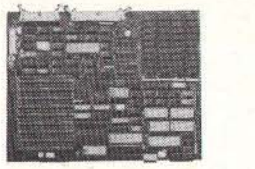

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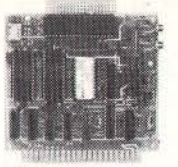

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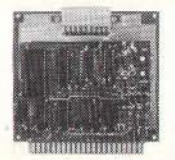

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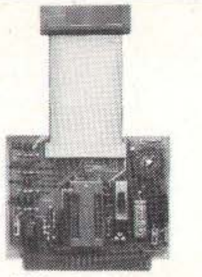

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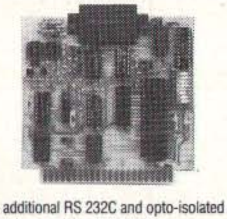

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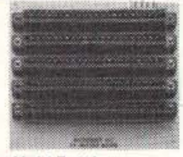

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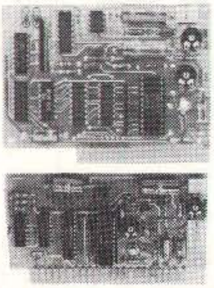

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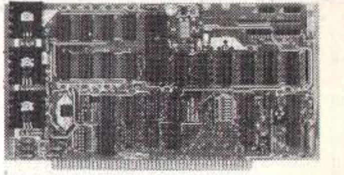

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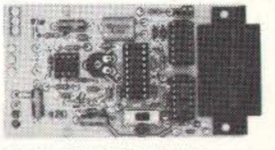

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of negative infinity for the MAS missing value, with the least significant byte replaced by the ASCII representation of the " . " character. This value is easily recognized and propagates as the SAS missing value does in comparisons. The preprocessor adds appropriate code in front of all assignment statements to check for missing values and propagate them as necessary.

Program Line-Parsing Techniques

The preprocessor program for handling SAS syntax reads the file containing the user's SAS-like source code, translating it into BASIC source code on a line-by-line basis. The ASCII BASIC code is written to several files, with one program file for each SAS step. Each of these program files has a chain instruction as its last executable step, so that the next program is executed in turn. The chain is started by the preprocessor, whose last executable instruction is a chain instruction that executes the first BASIC program. Shared variables are communicated with Microsoft BASIC's COMMON statement.

The proc steps were fairly easy to implement. For each proc, a core procedure that actually performs the work was written in BASIC, using ordinary statistical and computing algorithms. For each proc step encountered, the preprocessor writes code that stores variable names and other needed information in standard places, copies this code onto the BASIC source file, copies the core procedure onto the BASIC source file, and adds closing and chaining code to the end of the BASIC source file. The resulting BASIC program will then behave as if it were the appropriate SAS procedure with its supplied procedure information statements.

Implementing the data step, however, proved more difficult. Pseudocode is an arbitrary code, independent of system hardware, which must be translated into computer code. A SAS data step must have the ability to do the following: perform nonexecutable statements; initialize variables; open MAS files named in DATA statements for output; open files named in INFILE, SET, or MERGE statements for input; WHILE (observations, or obs, left on any input file and obs limit not exceeded); initialize user variables not in RETAIN to missing; perform executable statements; WEND; close files; chain to next BASIC program.

The preprocessor's job is to read the user's SAS-like code for the data step and generate a BASIC program in the pseudocode format. BASIC has another feature that eases the translation task: its program statements can be written in ASCII to a file in any order, but when loading or chaining the program, it places the statements in ascending order. As a result, the preprocessor need not save the code for forward references and write it out to the program file at the proper time. Instead, it can write code to the file as it must be generated. If, for example, the preprocessor is generating linear BASIC code at line 10000 inside a loop, and it needs to generate a subroutine outside the loop in the line-20000 range,

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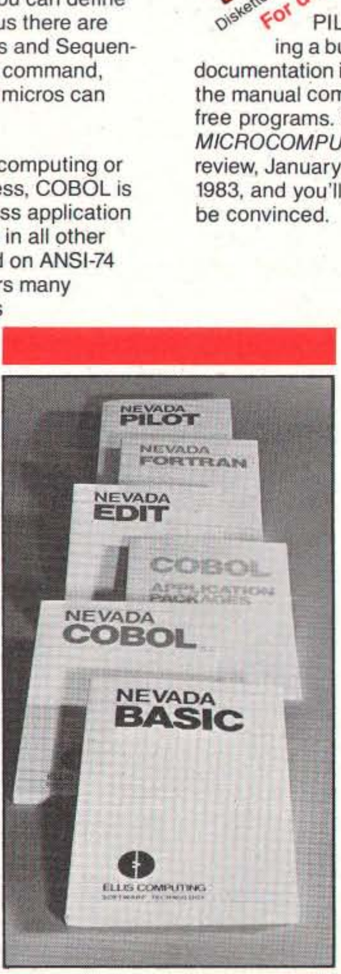

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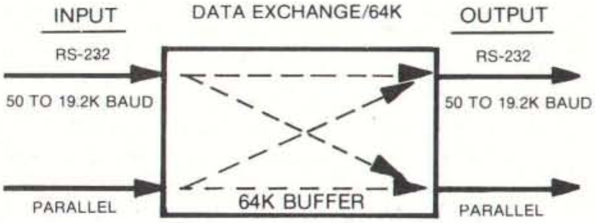

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it can do so. The code written to the program file will be line-10000 code, followed by the line-20000 range subroutine, followed by the rest of the line-10000-range code. The BASIC interpreter can thus dynamically alter the line numbers, then put them into their proper order when the program file is loaded.

Let's look carefully at each line of the pseudocode outline:

1. *Perform most nonexecutable statements.* While most SAS code used in the DATA step is executable code performed once for each observation in the output data set, this is not true of all SAS statements. DROP, KEEP, and RENAME affect the code that controls what variables and variable names will be stored on the output file, but do not affect each observation. The LABEL statement, for example, generates code that writes labels for the variables to the .HDR file for the data set but has no effect on the observations. No matter where these statements appear in the SAS data step, they generate code that acts once per DATA step rather than once per observation.
2. *Initialize variables.* Many counting and control variables, such as _N_, _ERROR_, and input line counters must be initialized before the observations loop.
3. *Open MAS files named in DATA step for output.* For every data set named in the DATA statement, the .HDR and .DAT files must be created and opened; then the data set name, label, time, and date of creation can be written to the .HDR file.
4. *Open files named in INFILE, SET, or MERGE statements for input.* For "raw input" files named in INFILE statements (which specify the input used to create a SAS data set), a sequential open is performed. For MAS data sets named in SET or MERGE statements, the .HDR file is opened to gain information about the data set, then the .HDR file is closed and the .DAT file is opened to permit direct input.

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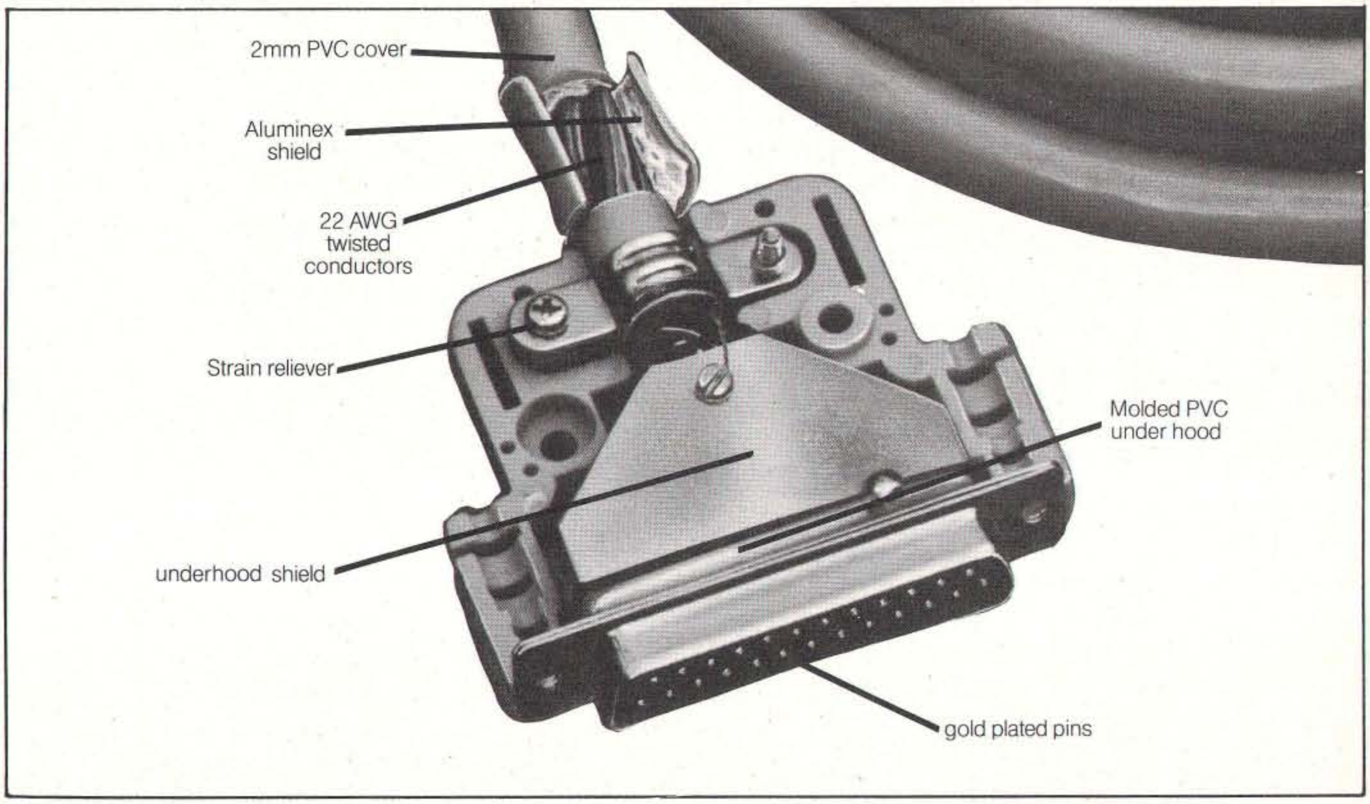

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5. *WHILE (obs left on any input file and obs limit not exceeded).* This WHILE. . .WEND loop does the real work of the DATA step. Until all of the input observations have been read, or until the user-set observation limit is reached, all statements within the loop are executed once per observation.

6. *Initialize user variables not in the RETAIN statement to missing.* At the beginning of each observation loop, all user variables are normally set to missing unless they have been named in the RETAIN statement. If they have been named in a RETAIN statement, they retain their values from the previous observation.

7. *Perform executable statements.* Here is where most of the work of the DATA step is performed. Each statement that affects the value of user variables (such as assignment or sum statements) or the way the observation is handled (such as subsetting IF, DELETE, LIST, IF. . .THEN. . .ELSE, or DO. . . WHILE. . .END) is translated into a BASIC statement or a subroutine. Standard subroutines are set up for such things as DELETE, LIST, and subsetting IF. Assignment statements are left almost unchanged, except for preceding each one with a trap for missing values so they will be correctly propagated. In the absence of explicit OUTPUT statements, an implicit output statement is placed at the end of the observations loop. It puts the current observation in all the output data sets named in the DATA statement.

8. *Close files.* All the open files are closed, and the observation count and appropriate statistics are written to the log file.

9. *Chain to the next BASIC program.* After completion of the DATA step, all control variables are saved in a COMMON area and the next BASIC program, which may correspond to a DATA or proc step, is executed.

Listing 1 shows a simple program written in SAS syntax and the printout that resulted when this program was run.

Listing 1: *A simple SAS program run on an IBM Personal Computer (PC) and the resulting printout.*

```
   The Source Code,

DATA TESTRUNS(LABEL=TEST RUNS FOR 5 NUMERIC VARIABLES);
  INPUT NOBS COMPILE DATA PRINT MEANS;
  CARDS;
   1 1.30   .03  .05  .15
   5 1.30   .10  .08  .22
  10 1.30   .17  .13  .28
  20 1.30   .32  .23  .42
  50 1.30   .79  .49  .86
 100 1.32  1.57  .93 1.57
 500 1.40  7.76 4.50 7.31
1000 1.49 15.51 8.97 14.48
  AVGDATA=DATA/NOBS;
  AVGPRINT=PRINT/NOBS;
  AVGMEANS=MEANS/NOBS;
PROC PRINT DATA=TESTRUNS;
  TITLE EXAMPLE MAS PROGRAM RUN TIMES IN MINUTES;
  TITLE2 TIMES ARE FOR COMPILE, DATA STEP, PROC PRINT AND PROC MEANS;
  TITLE3 EXAMPLE WAS DATA STEP WITH CARDS, THEN PROC PRINT, PROC MEANS;
  TITLE4 DATASET HAD 5 NUMERIC VARIABLES STORED IN DOUBLE PRECISION;
  TITLE5 ------++++++++-------;
  TITLE6 LISTING OF TIMES FOR VARIOUS QUANTITIES OF INPUT OBSERVATIONS;
  VAR NOBS COMPILE DATA PRINT MEANS;
PROC PRINT DATA=TESTRUNS;
  TITLE6 LISTING OF COMPUTED 'PER OBSERVATION' TIMES;
  VAR NOBS AVGDATA AVGPRINT AVGMEANS;
PROC MEANS DATA=TESTRUNS MAXDEC=2 N MEAN STD;
  TITLE6 AVERAGES OF 'PER OBSERVATION' TIMES;
  VAR AVGDATA AVGPRINT AVGMEANS;

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    The Resulting Printout.


 1 M I C R O C O M P U T E R   A N A L Y S I S   S Y S T E M 01-10-1983 20:23

 NOTE: THE JOB TESTRUNS.MAS HAS BEEN RUN UNDER RELEASE 82.7 OF MAS.


 1     DATA TESTRUNS(LABEL=TEST RUNS FOR 5 NUMERIC VARIABLES);
 2       INPUT NOBS COMPILE DATA PRINT MEANS;
 3       CARDS;
 12      AVGDATA=DATA/NOBS;
 13      AVGPRINT=PRINT/NOBS;
 14      AVGMEANS=MEANS/NOBS;

 NOTE: DATA SET TESTRUNS HAS 8 OBSERVATIONS AND 8 VARIABLES.  64 OBS/TRK.
 NOTE: THE DATA STATEMENT USED .2 MINUTES AND 20K.

 15    PROC PRINT DATA=TESTRUNS;
 16      TITLE EXAMPLE MAS PROGRAM RUN TIMES IN MINUTES;
 17      TITLE2 TIMES ARE FOR COMPILE, DATA STEP, PROC PRINT AND PROC MEANS;
 18      TITLE3 EXAMPLE WAS DATA STEP WITH CARDS, THEN PROC PRINT, PROC MEANS;
 19      TITLE4 DATASET HAD 5 NUMERIC VARIABLES STORED IN DOUBLE PRECISION;
 20      TITLE5 ------++++++++-------;
 21      TITLE6 LISTING OF TIMES FOR VARIOUS QUANTITIES OF INPUT OBSERVATIONS;
 22      VAR NOBS COMPILE DATA PRINT MEANS;

 NOTE: THE PROCEDURE PRINT USED .13 MINUTES AND 22K AND PRINTED PAGE 1.

 23    PROC PRINT DATA=TESTRUNS;
 24      TITLE6 LISTING OF COMPUTED 'PER OBSERVATION' TIMES;
 25      VAR NOBS AVGDATA AVGPRINT AVGMEANS;

 NOTE: THE PROCEDURE PRINT USED .15 MINUTES AND 21K AND PRINTED PAGE 2.

 26    PROC MEANS DATA=TESTRUNS MAXDEC=2 N MEAN STD;
 27      TITLE6 AVERAGES OF 'PER OBSERVATION' TIMES;
 28      VAR AVGDATA AVGPRINT AVGMEANS;

 NOTE: THE PROCEDURE MEANS USED .17 MINUTES AND 25K AND PRINTED PAGE 3.

 NOTE: MAS USED 1.17 MINUTES AND 25K.

 NOTE: BASS CYBERNETIC LABS
       RT. 1, BOX 124-B
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                EXAMPLE MAS PROGRAM RUN TIMES IN MINUTES    01-10-1983 20:23
         TIMES ARE FOR COMPILE, DATA STEP, PROC PRINT AND PROC MEANS
        EXAMPLE WAS DATA STEP WITH CARDS, THEN PROC PRINT, PROC MEANS
         DATASET HAD 5 NUMERIC VARIABLES STORED IN DOUBLE PRECISION
                          ------++++++++-------
        LISTING OF TIMES FOR VARIOUS QUANTITIES OF INPUT OBSERVATIONS

              OBS     NOBS      COMPILE  DATA      PRINT     MEANS

               1       1          1.3     .03       .05       .15
               2       5          1.3     .1        .08       .22
               3       10         1.3     .17       .13       .28
               4       20         1.3     .32       .23       .42
```

Listing 1 continued on page 432

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Listing 1 continued:

```
              5       50       1.3      .79      .49      .86
              6       100      1.32     1.57     .93      1.57
              7       500      1.4      7.76     4.5      7.31
              8       1000     1.49     15.51    8.97     14.48

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            EXAMPLE MAS PROGRAM RUN TIMES IN MINUTES    01-10-1983 20:23
     TIMES ARE FOR COMPILE, DATA STEP, PROC PRINT AND PROC MEANS
    EXAMPLE WAS DATA STEP WITH CARDS, THEN PROC PRINT, PROC MEANS
     DATASET HAD 5 NUMERIC VARIABLES STORED IN DOUBLE PRECISION
                          -------+++++++--------
            LISTING OF COMPUTED 'PER OBSERVATION' TIMES

            OBS    NOBS     AVGDATA  AVGPRINT AVGMEANS

             1      1        .03      .05      .15
             2      5        .02      .016     .044
             3      10       .017     .013     .028
             4      20       .016     .0115    .021
             5      50       .0158    .0098    .0172
             6      100      .0157    .0093    .0157
             7      500      .01552   .009     .01462
             8      1000     .01551   .00897   .01448

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

            EXAMPLE MAS PROGRAM RUN TIMES IN MINUTES    01-10-1983 20:23
     TIMES ARE FOR COMPILE, DATA STEP, PROC PRINT AND PROC MEANS
    EXAMPLE WAS DATA STEP WITH CARDS, THEN PROC PRINT, PROC MEANS
     DATASET HAD 5 NUMERIC VARIABLES STORED IN DOUBLE PRECISION
                          -------+++++++:-------
              AVERAGES OF 'PER OBSERVATION' TIMES

              VARIABLE       N        MEAN   STD. DEV.

              AVGDATA          8    .01819      .005
              AVGPRINT         8    .01595    .01397
              AVGMEANS         8    .03813    .04629
```

One final issue affects the translation of SAS statements to BASIC statements. Microsoft BASIC, like most BASICs, does not allow keywords to be used as variable names. Yet rather than restrict SAS variable names in this fashion, I added an extra letter to the beginning of all user variables that would appear in the BASIC program. Since neither Y nor Z is the beginning letter of any BASIC keyword, I used Y as the beginning letter of all numeric variables and Z as the first letter of all character variables. Thus the SAS user variable ABC becomes YABC in the BASIC program. The user never sees these names, however, since the BASIC program is never visible unless it is deliberately listed. This coding scheme also allows all the variables in the BASIC program beginning with Y to be set to double precision as well as all variables beginning with Z to be set to character-string type, using BASIC's DEFDBL and DEFSTR statements.

The preprocessor reads pseudocode for the data step and generates a BASIC program.

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echo	–echo arguments to stdout
expand	–expand tabs into spaces
expr	–string and arithmetic evaluation
false	–do nothing, unsuccessfully
find	–produce list of selected files
grep	–search files for specified pattern
hd	–hex file dumper
head	–output 1st lines of file
ls	–sorted directory list
more	–copy files to display
mv	–move files (rename)
num	–number lines
pr	–format files for printing
print	–pr directed to printer
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What Is SAS?

SAS stands for Statistical-Analysis System, a mainframe data-processing and statistical language, and series of software packages. It was developed at North Carolina State University in the late 1960s with grants from the National Institutes of Health and the U.S. Department of Agriculture for the purpose of providing an alternative to existing computer languages for statistical applications.

In 1972 the first statistical-analysis system made available to the public contained a data-management language and permitted a user to perform about 25 statistical procedures. It required users to write a simple program in a PL/I-like syntax that can take raw data from cards or tape and convert it into a standard SAS data set with a fixed internal form. The statistical procedures it offered required data in the form of SAS data sets and produced printed reports (and optionally, new SAS data sets) of such operations as linear and nonlinear regressions. Because the system demands a standard form for all data (the SAS data set), it frees the user from specifying data structures. In addition, the statistical procedures contained in SAS provide most commonly needed algorithms, so a SAS user can concentrate on statistical analysis rather than on coding algorithms. Listing 2 is a SAS program written in current SAS syntax.

Listing 2: *Written in the syntax of the latest version of SAS, this program can read four variables from a survey tape, create a SAS data set, calculate the variables' means and standard deviations, and use them to perform a linear regression.*

```
/* Example program with imaginary data set                                  */
/*   — demonstrates SAS syntax, not good statistics . . .                   */

                          /* SAS comments can be enclosed like this . . .   */

DATA INCOME;              /* Name of SAS data set to be created             */
  INFILE TAPE1455;              /* Data Definition Name of the Tape         */
  INPUT @15 INCOME              /* Income is at the 15th column of each record on */
                                /*   the tape                               */
      @22 AGE                   /* Age in years is at col 22                */
      @27 HEIGHT                /* Height in inches is at column 27         */
      @94 WEIGHT                /* Weight in pounds is at column 94         */

PROC MEANS DATA=INCOME MEAN STD          /* Printed report will contain means */
                                         /* and std devs for all the variables */

PROC SYSREG DATA=INCOME;                 /* A simple regression             */
  MODEL INCOME=AGE HEIGHT WEIGHT         /* of income on age, height and    */
                                         /* weight                          */
```

A Simple Yet Useful Language

The first group of statements make up a data step. The data step in listing 2 creates a SAS-style data set with four variables and as many observations as there are records on the tape. The variables can be picked off from any position on the record without the need for any COBOL-like fillers, and multiple records of any observation are easily handled. The next two groups of statements are PROC steps, which perform specified statistical procedures on the SAS data set that has been created. In this example, the data set is a temporary one, but it could just as easily be specified as a permanent data set.

The example in listing 2 would have required hundreds or even thousands of lines in such other languages as BASIC, FORTRAN, and Pascal. Thus, an advantage of SAS is that for many statistical and data-management tasks, it requires less programmer effort than do other languages. Yet SAS contains all the elements of a complete programming language (such as DO...WHILE...END and IF...THEN...ELSE statements and arrays) and can be used for complex nonstatistical programming tasks as well as statistical ones.

This useful language rapidly grew popular, first at universities and later in the business world. The maintenance of the package was transferred from the Institute of Statistics of North Carolina State University to a private firm, the SAS Institute, in July 1976. Expanded versions were released in 1976, 1979, and 1982, and all of them retained the concept of a standard SAS data set and a powerful, problem-oriented language to manipulate the data in them. Graphics, time-series, and operations-research procedures were offered as optional add-on packages, but all of the packages required a large IBM 370 mainframe computer or equivalent machine until 1982, when a new portable SAS was announced for some of the 32-bit super-minicomputers, such as Digital Equipment Corporation's VAX computers. At the time of this writing, these products were still in testing stages; however, the SAS Institute maintained that it had no plans for moving SAS to microcomputers. At a SAS conference in 1982, a suggestion was made in a microcomputer users' special-interest group that it might be possible to emulate a SAS-like syntax on a microcomputer, and that suggestion led to this article. The author has no connections with SAS Institute Inc.

Conclusion

We've examined some of the steps involved in implementing a SAS syntax preprocessor for Microsoft BASIC. Some characteristics of BASIC made the task easier than writing a true SAS compiler for a microcomputer. The main drawback of this type of solution, however, is the slow speed of the result. Compiling the resulting BASIC code instead of interpreting it should be possible, but since chaining and statement ordering are handled differently by the compiler and the interpreter, this solution has not been tried. It would be an excellent area for further work with this preprocessor. The exercise did show that a substantial portion of the SAS syntax can be implemented on a microcomputer, however, and that for small data sets, this subset can be used effectively.■

Jeff Bass is a senior analyst at Bass Cybernetic Labs (Rte. 1, Box 124B, Pittsboro, NC 27312).

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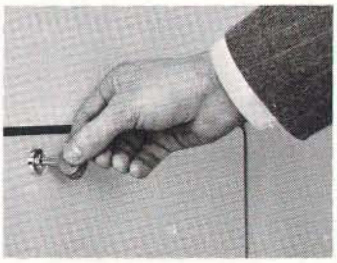

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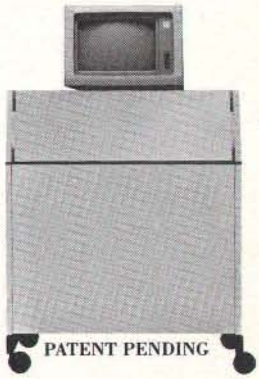

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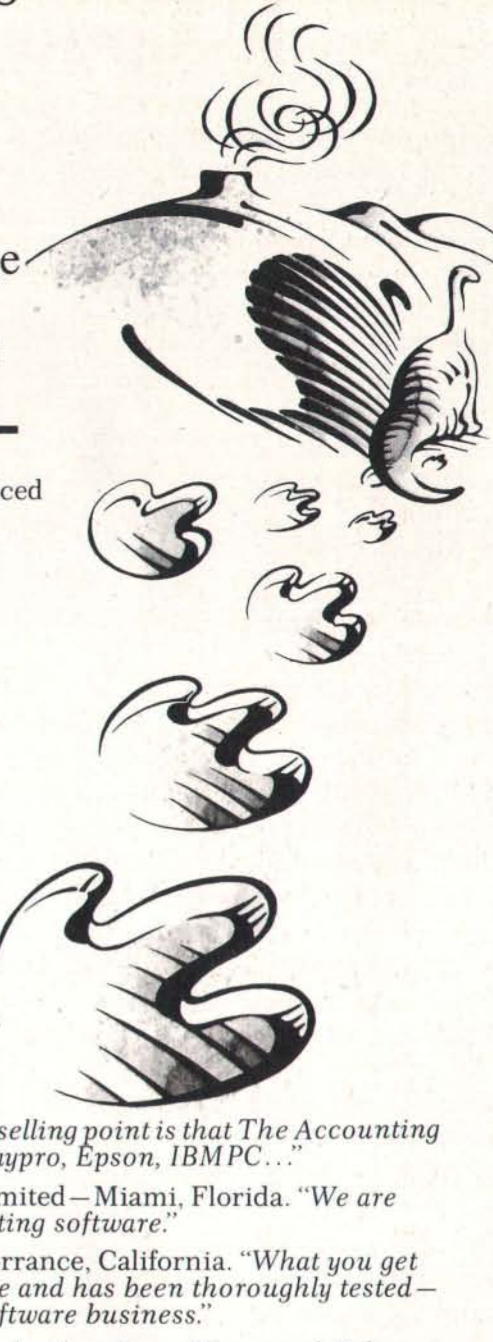

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A Software Review Method That Really Works

The detailed group walk-through approach involves "playing computer"

by Andrew Citron

Programming errors create major time and money problems for the computer industry, not to mention the frustration felt by the end user. As a result, an effective method of eliminating errors is crucial to the software designer. One successful method you can use is the group walk-through. Reviewing software design and code this way ensures a low error rate and catches errors often missed in testing. Other benefits include improved documentation and software that is integrated more smoothly into the system.

The Method

The walk-through review is fundamentally a process of "playing computer." The participants emulate what the computer does with the input data by actually walking through, from start to finish, a maximum of 5000 lines of code. With careful definition of the participants' roles, standardized written preparation, and several shortcuts, the walk-through provides a workable means of correcting programming problems. In addition, a group review reduces the risk of individual errors by allowing for cross-checking between participants.

Design documents or code are reviewed, but in either case the method remains basically the same. The design document may be in the form of PDL (programming design language, or structured English), structure trees, Nasi-Schneiderman diagrams, flowcharts, or even HIPO (hierarchy plus input, process, output) diagrams. Reviewers must be concerned with both the details and clarity of the design. Code, on the other hand, is rarely ambiguous.

Group review reduces the risk of individual errors by allowing for cross-checking between participants.

Test cases are run throughout the review; these form a series of inputs to the software and test the program's major requirements. All program statements should be tested at least once. Usually it is impossible to test all paths through the code because that number increases so quickly. By going through every statement at least once with all the main requirements included, the review participants test an adequate number of paths.

The Roles of the Participants

The review participants include the designer/coder and at least two other interested and motivated reviewers. Three seems to be the right number of people; four works, but the payoff does not increase proportionally.

Each participant has a specific role. The designer/coder remains passive while the other two reviewers are active. The designer/coder's role is to be alert for bugs and errors, answer questions, take notes on problems that need correcting, and provide the documentation and test cases for the walk-through. He does not "play computer." The designer is intensely involved with the program, and it is this involvement that increases the likelihood of repeating mistakes. Therefore, the other two reviewers are active. They remain impartial and follow the design exactly, rather than try to interpret what the designer meant. One reviewer acts as the central processor by reading the next instruction to be executed. The other writes down the variable's values for the others to see. The designer watches the two reviewers following the design or code blindly and immediately recognizes when something is wrong.

The Process

The reviewer emulating the central processor reads the statements one at a time, marking each one as it is read. If reviewers use a different color magic marker for each test case, they get a feel for the number of paths that have been tested.

The reviewer tracking storage and registers notes modified variables in a visible place. A blackboard, an overhead projector, or even paper glued to the walls enables all the reviewers to see the current values.

To walk through a test case, you follow the path the machine takes. When an IF statement is encountered, the storage and register tracker checks the variable being tested and chooses one path. Each case should be taken independently because a detailed understanding of the control flow is necessary to determine if the software functions properly. When the program calls a subroutine, you walk through it also, not bothering with external routines.

In the design review, macro interface parameters are specified and checked. In the code review, you check the coded parameters against the design and walk through the expanded macro code. This catches interface errors when existing macros are called. It also catches coding errors in new macro code. It's important that you pay close attention to macro parameters and generated code because interface errors are a major source of program problems.

When a problem is found in either the design or code review, you shouldn't make any attempt to solve it unless it's trivial. The designer's role is to note the error and fix it later. If the problems are many or serious, you walk through the program again after fixing it. The addition of many new conditional statements indicates serious program problems. After a number of insertions, changes occur in paths already reviewed, and you must plan to review the program again.

Shortcuts

Once it has been asserted that a subroutine works, walking through it again and again is avoided. Making this assertion applies a technique used in formal program proving: given a precondition (the input) and a process (the program), the postcondition (the output) is true.

Three conditions must be met to make such an assertion. First, you should prepare a detailed input statement. You must state which variables are input and where they can be found. Second, a detailed output specification should be created spelling out any variables the reviewers modify and the conditions under which they've changed them, also stating any side effects such as modified registers or static control blocks. Third, you must completely walk through the routine once. When you prove a program path works, you don't need to walk through it again but must simply verify that the input conditions have been met to assume that the output conditions are true. When the input and output statements are complete and correct and

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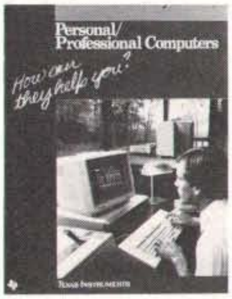

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all the reviewers agree that the subroutine functions correctly, the reviewer in charge of tracking variables updates the blackboard.

Another shortcut, stacking the machine state, helps you avoid walking through the same paths repeatedly. When you encounter an IF statement, write down the values of the variables and registers, note the point where the code diverges, and continue walking through the current test case. When you finish that case, you return to the machine state found at the IF statement, change the variable, and continue the walk-through.

With practice, you learn to design, code, and document programs so that review productivity improves. Input and output statements are then specified more fully, designed more simply, and use fewer variables.

Advantages of Walk-Throughs

The main advantage of walkthroughs is that reviewers find bugs earlier. And the sooner you find a problem, the cheaper it is to fix. The bugs found in reviews are often those that slip through testing: timing conditions, reentrancy problems, accidental storage modification. If you check only the testing output, you miss the side effects. Don't underestimate the value of finding and fixng these problems.

Another advantage is better documentation. Since the designer does not lead the walk-through, the two reviewers need comprehensive documentation. If documentation is incomplete, the reviewers know that something is unclear and needs fixng. You must spell out any design or code restrictions carefully. Documenation enhancements from reviews make the code more modifiable and maintainable.

Shortcomings of Walk-Throughs

While a walk-through doesn't produce a well-structured design, it guards against a bad one. If the review uncovers error after error, an experienced programmer throws the design out rather than repeatedly fixing and patching it. The major objection to walk-throughs, the time required, is not valid. Actually, a walk-

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through reduces time spent on future maintenance, testing, and integration.

Despite the completeness of walk-throughs, some errors still occur. The code must be tested; fortunately, it takes less time and effort to correct errors the second time around.

A Word on Attitude

Attitude makes the review work. New software has errors, and it's more constructive to find bugs in a review and in testing than later in production or in integration testing. Late error detection is time consuming and more difficult to correct. The proper ratio is to find many problems during the review, fewer in testing, and none when you integrate the code into the system. Error-free output from the walk-through is the reviewers' responsibility as much as the designer's.

Summary

Group walk-throughs of code and design ensure that software meets requirements, performs as intended, and has proper documentation. Well-defined reviewer roles, a proper structure, and a cooperative attitude produce an extremely effective group walk-through.■

Acknowledgments

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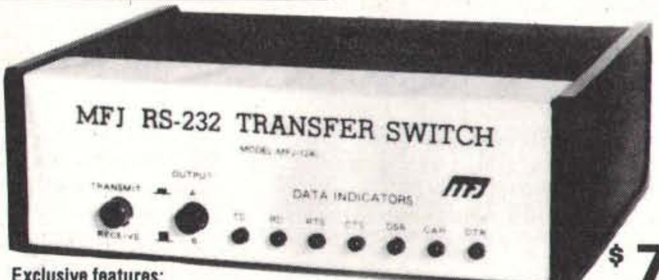

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Real-Time Clocks and PC-DOS 2.0

Understanding the clock/device-driver interface

by David K. Broadwell

Almost every multifunction board sold for the IBM PC includes a clock, each sold with its own proprietary software. Recognizing that these real-time add-on clocks are extremely popular, IBM and Microsoft made specific provisions in the PC-DOS version 2.0 to legitimize the clocks' existence and handle their functions in a uniform way. The mechanism for this is a provision for device drivers—assembly-language (.COM) programs that can supplement or replace existing system software for doing the I/O (input/output) to a specific logical device. In this article I will provide a brief introduction to device drivers and discuss and demonstrate a character device-driver program for the clock chip on a typical multifunction board. In addition to being a nifty utility, the program demonstrates several features of 8088 code and the macroassembler.

By now, nearly all of us who bought PC-DOS 2.0 have thumbed through its accompanying volume at least once. Of all the additions inspired by Unix, perhaps the most important new feature is its powerful device-driver capability. Without using "dirty tricks" or mucking about in the system software, you can now integrate new devices into the operating environment quickly and in a manner compatible with current and, presumably, future versions of PC-DOS. Manufacturers of add-on boards, peripherals, and other hardware can now develop standardized software to interface their products to the IBM PC. System integrity is maintained no matter how many bells, whistles, and real-time gadgets are added.

CLOCK.COM requirements:
IBM PC
64K bytes of RAM
one floppy-disk drive
PC-DOS 2.0
Any AST Research Inc. (2372 Morse Ave., Irvine, CA 92714, 714-540-1333) Multifunction board with National Semiconductor MM58167A Real-Time Clock chip.

PC-DOS 2.0 recognizes two types of devices: character and block. [**Editor's Note:** *For a detailed discussion of device drivers and the IBM PC, refer to "Installable Device Drivers for PC-DOS 2.0" by Tim Field, November 1983 BYTE, page 188.*] As the name implies, character devices do serial I/O on characters and include a system's PRN (printer), AUX (auxiliary), and CON (console) logical devices. The newly defined system device CLOCK$ falls into this category. Block devices, on the other hand, include hard and floppy disks and do random I/O in chunks that usually correspond to a physical sector size for efficiency.

As an example of device-driver operations, assume you already have a device driver that simulates a floppy disk in RAM (random-access read/write memory). (You can use the device driver in the DOS 2.0 manual.) When PC-DOS 2.0 is booted up, it looks for a file named CONFIG.SYS, which contains information on how the system is to be initialized. Among other things, this file can contain a number of statements of the form DEVICE=filename. If our RAM disk-driver example is called VDISK.COM, we put it into our CONFIG.SYS file for DEVICE=VDISK.COM. This driver is loaded and left resident as a permanent and transparent part of the system. Any I/O calls to the virtual RAM disk are handled through regular channels, without altering the 8088's interrupt vector table that the DOS sets up. This is why a virtual-disk program that worked under DOS 1.1 bombs out under version 2.0.

The logical device we are replacing is the system CLOCK$. A device driver named CLOCK.COM is installed instead of the system's default software, and it is loaded by a DEVICE=CLOCK.COM statement in CONFIG.SYS—at start-up time. Each time a call is made to read or set the date and/or time, CLOCK.COM does it. This includes the DOS commands for DATE, TIME, and pertinent DOS INT (hexadecimal) 21 file-management function calls. My clock-driver program reads and sets the National Semiconductor MM58167A Real Time Clock chip on an AST Research Inc. Combo board, but the general principles for any clock driver are represented as well as what PC-DOS 2.0 requires of a character device.

What PC-DOS 2.0 expects from a device-driver program and how they communicate are explained in the PC-DOS 2.0 manual. As previously mentioned, the RAM disk example is a handy block-device driver. Character devices, however, are quite different, and the CLOCK$ device is also a rather special subset. Both devices use drivers structured the same way, but each is asked to do different functions by the DOS. The system creates a structure called a Request Header and passes its address

Static Header		
	Byte (0)	length in bytes of Request Header (13) plus data block that follows (if any)
	Byte (1)	subunit code for block devices (not used here)
	Byte (2)	command code, e.g., "READ" = 08
	Byte (3–4)	STATUS word (DONE, ERROR CODE, BUSY)
	Byte (5-12)	reserved for DOS
	Byte (13)	media descriptor (block device only—not used)
Variable		
	DWORD (14–17)	double-word address of system buffer for transferring data
	Word	number of bytes/sectors transferred—always six for the clock, so not really used

Figure 1: *A Request Header and block format for read/write to system CLOCK$.*

pointer to the driver program in the extra segment (ES) register and general register (BX). All function requests, data transfers, and status checks occur through this mechanism. Following the 13-byte Request Header is an area whose length depends on what is appropriate for that particular operation. It might contain a data buffer address, initialization data, or specific device parameters the system needs to know. The format for a Request Header and the accompanying data block for our clock driver are shown in figure 1.

To continue, we'll first look at the requirements of an installable driver and then how it works within the operating system by referring to listing 1. The general format of IBM's example program is followed for easier comparison between block and character logic.

Device-Driver Structure

A device driver is a .COM file, but because it doesn't use a program-segment prefix when it's run, the code must start at 0. There is no ORG hexadecimal 100 statement as in other .COM files.

The special device header appears after all the MACROS, STRUCTURES, and EQUATES are defined. It is the logical beginnig of the program and identifies the device's attributes (which are set here for character type and current clock device), its name, and pointers to crucial parts of the program. The first double word is set to −1 unless more than one driver is in that particular .COM file.

Device Strategy (page 447) is an area of the program that saves a pointer passed to it in ES:BX. This is the address of the Request Header that PC-DOS 2.0 uses to pass data back and forth to the driver. A driver is called at this entry point to prioritize the system's request.

Device Interrupt Handler (page 448) is an area of the program called (with no parameters) directly after Device Strategy concludes. It retrieves the Request Header address, saves the registers, and services the system's request. (Interestingly, the IBM example failed to retrieve the Request Header's address. Apparently, ES:BX doesn't change at present, but CLOCK.COM follows the protocol anyway.) Both the Strategy and Interrupt addresses are stored in the device header.

A Command Code byte is passed in the Request Header, indicating the function desired of the device. The driver must decode and service this request. All drivers have an initialization call when the system is booted. As written, many other functions are possible, including nondata I/O control of the device (IOCTL). CLOCK does only simple input (read clock) and output (set clock). A call to do anything else results in the status word going back to the DOS coded as "unknown command."

It is the driver's responsibility to save the machine state, and there seems to be enough room on the DOS stack to do this as well as use PUSH and POP a few extra times.

Text continued on page 449

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Listing 1: *A replacement system clock/device driver based on the IBM PC macroassembler.*

```
                          TITLE   Replacement system clock driver for AST Board
                          COMMENT* This is an installable device driver to access the battery
                                  driven clock on AST combo board @ I/O port 2C0 + 1F *
                          COMMENT* Author: David K. Broadwell -- July 1983 *
                          ;
                          ;
0000                      CSEG    SEGMENT PARA PUBLIC 'CODE'
                          ;
                          ;       M A C R O S
                          ;
                          STATUS  MACRO   STATE,ERR,RC
                                  ifidn   <STATE>,<DONE>
                                  OR      ES:WORD PTR SRH_STA_FLD[BX],0100H
                                  endif
                                  ifidn   <STATE>,<BUSY>
                                  OR      ES:WORD PTR SRH_STA_FLD[BX],0200H
                                  endif
                                  ifidn   <ERR>,<ERROR>
                                  OR      ES:WORD PTR SRH_STA_FLD[BX],1000H
                                  endif
                                  ifnb    <RC>
                                  OR      ES:WORD PTR SRH_STA_FLD[BX],RC
                                  endif
                                  endm
                          ;


                          ;
                          ;       E Q U A T E S
                          ;
                          ;
= 0000                    SRH             EQU     0               ;STATIC REQUEST HEADER START
= 000D                    SRH_LEN         EQU     13              ; "     "      "      LENGTH
=                         SRH_LEN_FLD     EQU     SRH             ; "     "      "      "      FIELD
= 0001                    SRH_UCD_FLD     EQU     SRH+1           ;SRH UNIT CODE FIELD
= 0002                    SRH_CCD_FLD     EQU     SRH+2           ;SRH COMMAND CODE FIELD
= 0003                    SRH_STA_FLD     EQU     SRH+3           ;SRH STATUS FIELD
= 0005                    SRH_RES_FLD     EQU     SRH+5           ;SRH RESERVED AREA FIELD
                          ;
                          ; INPUT OR OUTPUT
= 000E                    BUF             EQU     14              ;OFFSET INTO THE REQ BLOCK OF DATA(BUFFER) TRANSFER ADDRESS
= 0004                    BUF_LEN         EQU     4               ;BUF LENGTH
                          ;
                          ;INIT
                          ;
= 000E                    BR_ADDR_0       EQU     14              ;CHARACTER DEVICE USUALLY ONLY SETS
= 0010                    BR_ADDR_1       EQU     BR_ADDR_0+2     ; ENDING ADDR AND RETURNS
= 0004                    BR_ADDR_LEN     EQU     4
                          ;
                          ; OFFSETS FROM CLOCK BASE PORT
                          ;
= 0007                    MON             EQU     7               ;OFFSET OF MONTH
= 0006                    DAYY            EQU     6               ;  "    OF DAY OF MONTH
= 0008                    VALID           EQU     8               ;  "    OF VALIDATION CODE IN RAM
= 0009                    MON_CHEK        EQU     9               ;  "    OF MONTH CHECKER IN RAM
= 000B                    SWITCH          EQU     0BH             ;  "    OF LEAP BK RAM ON CHIP
= 0012                    COUNTER_RESET   EQU     12H             ;  "    OF RESET(RAM RESET IS ONE UP AT 13H)
= 0014                    STATUS_BIT      EQU     14H             ;OFFSET TO STATUS BYTE--80=UNRELIABLE READ,00=OK
                          ;
                          ; MISC
                          ;
= 016D                    DAYS_YR         EQU     365             ;DAYS PER USUAL YEAR
= 0002                    YES_CODE        EQU     02              ;YES CODE FOR LEAP YEAR BOOKEEPING
= 0001                    NO_CODE         EQU     01              ;NO CODE FOR SAME
= 0010                    VALID_CODE      EQU     10H             ;VALIDATE CHIP CODE
= 003C                    DAYS_FEB29      EQU     60              ;DAYS UP TO AND INCLUDING FEB 29TH(FOR LEAP YEARS ONLY)
                          ;
                          ; S T R U C T U R E S
                          ;
= 02C0                    CLOCK           EQU     2C0H            ;BASE PORT
                          ; mm58157A CLOCK-CALENDAR CHIP I/O ADDRESSES
                          ;
                          CLOCK_PORTS     STRUC
0000  ??                  TEN_THOUS       DB      ?               ;1/10000s of seconds(who cares?)
0001  ??                  HUNDS           DB      ?               ;hundredths
0002  ??                  SECS            DB      ?               ;seconds
0003  ??                  MINS            DB      ?               ;minutes
0004  ??                  HRS             DB      ?               ;hours
0005  ??                  WEK_DAY         DB      ?               ;day of week
0006  ??                  DAY             DB      ?               ;day of month
0007  ??                  MO              DB      ?               ;month
0008  ??                  VERIFY          DB      ?               ;chip RAM used to check chip config at initialization
0009  ??                  MON_CHK         DB      ?               ;RAM with month of last chip access
000A  ??                  YR              DB      ?               ;year-1980 (port 2C0+0A)
000B  ??                  LEAP_BK         DB      ?               ;used for leap year bookeeping (set to 02  when all is cool
                          ;
000C                      CLOCK_PORTS     ENDS
                          ;


                          ;


                          ;
0000                      CLK     PROC    FAR
                                  ASSUME  CS:CSEG,ES:CSEG,DS:CSEG
0000                      BEGIN:
                          ;       S P E C I A L   D E V I C E   H E A D E R
0000  FF FF FF FF         NEXT_DEV        DD      -1              ;POINTER TO NEXT DEVICE
0004  8008                ATTRIBUTE       DW      8008H           ;CLOCK DEVICE (NEW STD.
0006  02BF R              STRATEGY        DW      DEV_STRATEGY    ;POINTER TO DEVICE STRATEGY
0008  029A R              INTERRUPT       DW      DEV_INT         ;POINTER TO INTERRUPT HANDLER
000A  43 4C 4F 43 4B 24   DEV_NAME        DB      'CLOCK$'          ;DEVICE NAME
0010     02 [                             DB      2 DUP(?)        ;FILLER
                   ??
                        ]


                          ;
0012  ????                RH_OFF          DW      ?               ;REQUEST HEADER OFFSET
0014  ????                RH_SEG          DW      ?               ;R HDR SEGMENT
0016  ????????            USER_BUF        DD      ?               ;USER TRANSFER ADDRESS(BUFFER)
                          ;
                          ;    FUNCTION TABLE
                          ;
001A                      FUNTAB  LABEL   BYTE
001A  0319 R                      DW      INIT            ;INITIALIZATION    -USED FIRST TIME DEVICE IS CALLED
001C  02BD R                      DW      MEDIA_CHECK     ;(BLOCK ONLY)      -NOT USED
001E  02BD R                      DW      BUILD_BPB       ;      "           -NOT USED
0020  02BD R                      DW      IOCTL_IN        ;IOCTL INPUT       -NOT USED
0022  02D2 R                      DW      INPUT           ;INPUT(READ) = GET THE TIME/DATE
0024  02BD R                      DW      ND_INPUT        ;NON-DESTRUCTIVE INPUT(CHAR ONLY) -NOT USED
0026  02BD R                      DW      IN_STAT         ;CHAR ONLY         -NOT USED
0028  02BD R                      DW      IN_FLUSH        ;C.O               -NOT USED
002A  02F1 R                      DW      OUTPUT          ;OUTPUT(WRITE) = SET TIME/DATE
002C  02BD R                      DW      OUT_VERIFY      ;OUTPUT W/ VERIFY -NOT USED
```

Listing 1 continued on page 445

Listing 1 continued:

```
002E  02BD R                    DW      OUT_STAT        ;C.O.              -NOT USED
0030  02BD R                    DW      OUT_FLUSH       ;C.O.              -NOT USED
0032  02BD R                    DW      IOCTL_OUT       ;IOCTL OUTPUT      -NOT USED
                        ;
                        ;

                        ;       LOCAL DATA BLOCK IN DOS 2.0 FORMAT
                        ;
0034                    CLK_TBL LABEL   BYTE
0034  ????                      DW      ?               ;DAYS SINCE 1-1-80
0036  ??                        DB      ?               ;MINS
0037  ??                        DB      ?               ;HRS
0038  ??                        DB      ?               ;1/100THS SEC
0039  ??                        DB      ?               ;SECS
                        ;
                        ;       MONTH TABLE
                        ;
003A                    MON_TBL LABEL   BYTE
003A  0000                      DW      0               ;JAN
003C  001F                      DW      31              ;FEB
003E  003B                      DW      59              ;MAR
0040  005A                      DW      90              ;APR
0042  0078                      DW      120             ;MAY
0044  0097                      DW      151             ;JUNE
0046  00B5                      DW      181             ;JULY
0048  00D4                      DW      212             ;AUG
004A  00F3                      DW      243             ;SEPT
004C  0111                      DW      273             ;OCT
004E  0130                      DW      304             ;NOV
0050  014E                      DW      334             ;334 DAYS UP TO DEC 1
0052  016D                      DW      365             ;DAYS UP TO JAN 1, NEXT YR
                        ;
                        ;       TABLE OF CURRENT CLOCK VALUES
                        ;
0054  ??                UHR     CLOCK_PORTS     <>      ;Allocates according to predefined STRUC
0055  ??
0056  ??
0057  ??
0058  ??
0059  ??
005A  ??
005B  ??
005C  ??
005D  ??
005E  ??
005F  ??


                        ;
                        ;       VARIABLES FOR TRACKING THOSE PESKY LEAP YEARS
0060  00                LEAP_STAT       DB      0       ;10H MEANS CURRENT YR IS A LEAP
0061  ??                NUM_CEAPS       DB      ?       ;NUMBER OF LEAP YEARS SINCE 1980
                        ;


                        ;
                        ;   L O C A L   P R O C E D U R E S
                        ;
0062                    IN_SAVE PROC    NEAR
0062  26: 8B 47 0E              MOV     AX,ES:WORD PTR BUF[BX]  ;SAVE CALLER'S BUFFER ADD
0066  2E: A3 0016 R             MOV     CS:USER_BUF,AX
006A  26: 8B 47 10              MOV     AX,ES:WORD PTR BUF+2[BX]
006E  2E: A3 0018 R             MOV     CS:USER_BUF+2,AX
0072  C3                        RET
0073                    IN_SAVE ENDP
                        ;
0073                    READ_CLOCK      PROC NEAR
0073  0E                        PUSH    CS                      ;SET UP TO READ CHIP AND STORE IT
0074  07                        POP     ES
0075  8D 3E 0054 R      RETRY:  LEA     DI,UHR
0079  FC                        CLD
007A  2B C0                     SUB     AX,AX
007C  B9 000C                   MOV     CX,12
007F  BA 02C0                   MOV     DX,CLOCK                ;ADDRESS OF CHIP BASE PORT
0082  EC                LOADIT: IN      AL,DX
0083  42                        INC     DX
0084  51                        PUSH    CX
0085  E8 0132 R                 CALL    DEC_HEX                 ;CONVERT BCD TO HEX
0088  AA                        STOSB
0089  59                        POP     CX                      ;RESTORE COUNTER
008A  E2 F6                     LOOP    LOADIT
                        ;
                        ;   Check for counter rollover during read(STATUS BYTE=80H)
                        ;
008C  BA 02D4                   MOV     DX,CLOCK+STATUS_BIT
008F  EC                        IN      AL,DX
0090  84 C0                     TEST    AL,AL
0092  75 E1                     JNZ     RETRY
                        ;
                        ;   Routines to massage data for transfer to DOS
                        ;
0094  E8 0110 R                 CALL    NEW_YEAR                ;CHECK TO SEE IF IT'S A NEW YEAR
0097  E8 00AF R                 CALL    DAYS                    ;NUMBER OF DAYS SINCE 1/1/80
009A  E8 00ED R                 CALL    TIME                    ;CURRENT TIME IN HEX
                        ;
009D  2E: 8E 06 0018 R          MOV     ES,CS:USER_BUF+2        ;SET DESTINATION (ES:DI) TO POINT TO
00A2  2E: 8B 3E 0016 R          MOV     DI,CS:USER_BUF          ;CALLER'S BUFFER
00A7  0E                        PUSH    CS
00A8  1F                        POP     DS                      ;ESTABLISH SOURCE
                                                                ;SI ALREADY HAS CLK_TBL ADDRESS
00A9  B9 0006                   MOV     CX,6                    ;6 BYTES
00AC  F3/ A4            REP     MOVSB                           ;SEND INFO TO BUFFER FOR "READ"
00AE  C3                        RET
00AF                    READ_CLOCK      ENDP
                        ;
                        ;


00AF                    DAYS    PROC    NEAR
00AF  2B C0                     SUB     AX,AX
00B1  A0 005E R                 MOV     AL,UHR.YR               ;YEAR-1980
00B4  BB 016D                   MOV     BX,DAYS_YR
00B7  F7 E3                     MUL     BX                      ;MUL FOR DAYS
00B9  2B C9                     SUB     CX,CX
00BB  8A 0E 005B R              MOV     CL,UHR.MO               ;LOAD MONTH IN CL AND ...
00BF  E8 0104 R                 CALL    DAYS_MONTH              ; CALL ROUTINE TO ACCESS MONTH TABLE
00C2  03 07                     ADD     AX,WORD PTR[BX]         ;ADD THAT YEAR'S DAYS(XCEPT CUR MO)
00C4  32 FF                     XOR     BH,BH
00C6  8A 1E 005A R              MOV     BL,UHR.DAY              ;GET DAY OF MON
00CA  03 C3                     ADD     AX,BX                   ;DAYS SINCE 1-1-80, EXCEPT LEAP DAYS
00CC  50                        PUSH    AX
00CD  A0 005E R                 MOV     AL,UHR.YR
00D0  E8 0151 R                 CALL    LEAP_CHK                ;CHECK THOSE TOO
00D3  58                        POP     AX
```

Listing 1 continued on page 446

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Listing 1 continued:

```
00D4  2B D2                       SUB     DX,DX
00D6  BA 16 0061 R                MOV     DL,NUM_LEAPS
00DA  03 C2                       ADD     AX,DX                   ;ADD IN OLD LEAP DAYS
00DC  F6 06 0060 R 10             TEST    LEAP_STAT,10H           ;CURRENT YEAR A LEAP?
00E1  74 03                       JZ      D1                      ;JMP ON NO
00E3  E8 0173 R                   CALL    LEAP_ADJ                ;YES -GO FIX THINGS
00E6  8D 36 0034 R        D1:     LEA     SI,CLK_TBL
00EA  89 04                       MOV     WORD PTR [SI],AX        ;SAVE RESULT
00EC  C3                          RET
00ED                      DAYS    ENDP
                          ;
                          ;   GET HRS,MIN,SEC,1/100THS SEC
                          ;
00ED                      TIME    PROC    NEAR
00ED  8D 3E 0036 R                LEA     DI,CLK_TBL[2]           ;SET UP TO LOAD DATA LOCALLY IN RIGHT ORDER
00F1  32 E4                       XOR     AH,AH
00F3  A0 0057 R                   MOV     AL,UHR.MINS
00F6  AA                          STOSB
00F7  A0 0058 R                   MOV     AL,UHR.HRS
00FA  AA                          STOSB
00FB  A0 0055 R                   MOV     AL,UHR.HUNDS
00FE  AA                          STOSB
00FF  A0 0056 R                   MOV     AL,UHR.SECS
0102  AA                          STOSB
0103  C3                          RET
0104                      TIME    ENDP
                          ;
0104                      DAYS_MONTH      PROC    NEAR            ;MONTH ARRIVES HERE IN CL
0104  80 E9 01                    SUB     CL,1                    ;ADJUST TO GET THE CORRECT
0107  D0 C1                       ROL     CL,1                    ;    OFFSET INTO THE TABLE
0109  8D 1E 003A R                LEA     BX,MON_TBL              ;GET ADDR OF MONTH TABLE
010D  03 D9                       ADD     BX,CX                   ;NOW WORD PTR[BX] HAS NUM OF DAYS UP TO CURRENT MO
010F  C3                          RET
0110                      DAYS_MONTH      ENDP
                          ;


                          ;
0110                      NEW_YEAR PROC   NEAR                    ;CHECK FOR A "NEW YEAR" AND/OR UPDATE MON_CHK
0110  A0 005B R                   MOV     AL,UHR.MO               ;CURRENT MONTH
0113  3A 06 005D R                CMP     AL,UHR.MON_CHK          ;STORED ON CHIP- THE LAST "MONTH" WE READ IT
0117  7C 03                       JL      NEW                     ; 1<12 SO IT'S A NEW YEAR
0119  7F 0F                       JG      UPDATE                  ; IT'S A NEW MONTH
011B  C3                          RET                             ; SAME OLD MONTH - GO BACK
011C  FE 06 005E R        NEW:    INC     UHR.YR                  ; LAST YEAR - 1980, +1
0120  A0 005E R                   MOV     AL,UHR.YR
0123  E8 0142 R                   CALL    HEX_DEC                 ;MAKE IT BCD LIKE EVERYTHING ELSE
0126  BA 02CA                     MOV     DX,CLOCK+10             ;RAM ADDR FOR YR
0129  EE                          OUT     DX,AL
012A  A0 005B R           UPDATE: MOV     AL,UHR.MO               ;UPDATE MON_CHK ON RAM
012D  BA 02C9                     MOV     DX,CLOCK+9
0130  EE                          OUT     DX,AL
0131  C3                          RET
0132                      NEW_YEAR ENDP
                          ;
0132                      DEC_HEX PROC    NEAR                    ;CONVERTS SMALL PACKED BCD TO HEX
0132  50                          PUSH    AX
0133  B1 04                       MOV     CL,4
0135  D2 E8                       SHR     AL,CL
0137  5B                          POP     BX
0138  B7 0A                       MOV     BH,10
013A  F6 E7                       MUL     BH
013C  80 E3 0F                    AND     BL,0FH
013F  02 C3                       ADD     AL,BL
0141  C3                          RET
0142                      DEC_HEX ENDP
                          ;
                          ;
0142                      HEX_DEC PROC    NEAR                    ;CONVERTS HEX NUMBERS UP TO 63H(=99) TO BCD
0142  2A E4                       SUB     AH,AH                   ;HEX NUMBER PASSED IN AL
0144  B3 0A                       MOV     BL,10
0146  F6 F3                       DIV     BL
0148  B1 04                       MOV     CL,04
014A  D2 E0                       SHL     AL,CL
014C  86 C4                       XCHG    AL,AH
014E  0A C4                       OR      AL,AH
0150  C3                          RET                             ;BCD IN AL
0151                      HEX_DEC ENDP


                          ;
0151                      LEAP_CHK PROC   NEAR                    ;SETS NUMBER OF LEAP YEARS PAST & STATUS BYTE
0151  3C 00                       CMP     AL,0                    ;IS IT 1980?
0153  74 1D                       JE      L2                      ;YES - FORGET THE REST
0155  32 E4                       XOR     AH,AH                   ;PUT YEAR-1980 IN AL BEFORE CALL
0157  FE C8                       DEC     AL
0159  B3 04                       MOV     BL,4
015B  F6 F3                       DIV     BL
015D  80 FC 03                    CMP     AH,3
0160  75 08                       JNE     NOT_LEAP
0162  80 0E 0060 R 10             OR      LEAP_STAT,10H           ;SET LEAP STATUS BIT ON(CURR YR IS A LEAP)
0167  EB 06 90                    JMP     L1
016A                      NOT_LEAP:
016A  C6 06 0060 R 00             MOV   LEAP_STAT,0
016F  A2 0061 R           L1:     MOV     NUM_LEAPS,AL            ;NUMBER OF LEAP DAYS SINCE 1980
0172  C3                  L2:     RET
0173                      LEAP_CHK ENDP
                          ;
0173                      LEAP_ADJ        PROC    NEAR            ;ADJUSTS CHIP AND/OR DAYS COUNT DURING LEAPS
0173  80 3E 005F R 02             CMP     UHR.LEAP_BK,YES_CODE    ;HAVE WE ALREADY DONE THE BOOKEEPING?
0178  74 4B                       JE      DONE1                   ;JUMP ON YES
017A  8A 3E 005B R                MOV     BH,UHR.MO               ;IS IT BEFORE/AT FEB29? ---(CHIP THINKS IT'S 3/1)
017E  8A 1E 005A R                MOV     BL,UHR.DAY
0182  81 FB 0301                  CMP     BX,0301H
0186  7E 3B                       JLE     DONE2                   ;YES - JUMP
                          ;BACK UP A DAY AND RECORD IT IN RAM:
                          ;
0188  80 3E 005A R 01             CMP     UHR.DAY,1               ;IS IT THE 1ST OF A MONTH?
018D  74 16                       JE      FOOEY                   ;JUMP ON YES AND WHAT A PAIN
018F  50                          PUSH    AX                      ;NO -JUST BACK UP ONE DAY AND SET LEAP_BK
0190  32 E4                       XOR     AH,AH
0192  A0 005A R                   MOV     AL,UHR.DAY
0195  FE C8                       DEC     AL
0197  BA 02C6             BAK:    MOV     DX,CLOCK+DAYY           ;CHIP PORT
019A  EE                          OUT     DX,AL
019B  B0 02                       MOV     AL,YES_CODE
019D  BA 02CB                     MOV     DX,CLOCK+SWITCH
01A0  EE                          OUT     DX,AL                   ;SET LEAP_BK ON RAM SO WE WON'T HAVE TO DO THIS AGAIN
01A1  58                          POP     AX
01A2  EB 1F 90                    JMP     DONE2
                          ;
01A5  2B C9               FOOEY:  SUB     CX,CX                   ;BACK UP DAY AND MONTH BOTH
```

Listing 1 continued on page 447

Listing 1 continued:

```
01A7  BA 0E 005B R                   MOV     CL,UHR.MO
01AB  50                             PUSH    AX
01AC  8B C1                          MOV     AX,CX
01AE  BA 02C7                        MOV     DX,CLOCK+MON
01B1  FE CB                          DEC     AL
01B3  EE                             OUT     DX,AL
01B4  83 C2 02                       ADD     DX,2                    ;RESET MONTH VERIFY ON RAM TOO
01B7  EE                             OUT     DX,AL
01B8  E8 0104 R                      CALL    DAYS_MONTH
01BB  8B 07                          MOV     AX,WORD PTR[BX]         ;NOW FIND HOW MANY DAYS LAST MONTH HAD
01BD  2B 47 FE                       SUB     AX,WORD PTR[BX]-2       ;YESTERDAY NOW IN AL
01C0  EB D5                          JMP     BAK                     ;FINISH UP
                                     ;
01C2  40                  DONE1:     INC     AX                      ;ALL THE REST OF YR ADD ONE MO' DAY
01C3  C3                  DONE2:     RET
01C4                      LEAP_ADJ           ENDP


                                     ;
                                     ;
01C4                      SET_CLOCK          PROC    NEAR            ;GETS DATA FROM DOS, CRUNCHES IT & SETS CHIP
01C4  2E: 8E 1E 0018 R               MOV     DS,CS:USER_BUF+2        ;SET SOURCE TO CALLER'S (DOS)BUFFER BLK ADR
01C9  2E: 8B 36 0016 R               MOV     SI,CS:USER_BUF
01CE  0E                             PUSH    CS
01CF  07                             POP     ES
01D0  8D 3E 0034 R                   LEA     DI,CLK_TBL
01D4  B9 0006                        MOV     CX,6                    ;SET UP TO MOVE DATA LOCALLY
01D7  FC                             CLD
01D8  F3/ A4              REP        MOVSB                           ;DO IT
                          ;
                          ; CALCULATE AND LOAD LOCAL CLOCK CHIP TABLE (STRUCTURE)
                          ;
01DA  0E                             PUSH    CS
01DB  1F                             POP     DS                      ;ESTABLISH DS AS THIS SEG
01DC  E8 01F9 R                      CALL    LOAD_TICKS              ;DO TIME PART(EASY)
01DF  E8 0210 R                      CALL    UNSCRAM                 ;DAYS TO YR-MO-DAY
                          ;
                          ; SET CHIP
                          ;
01E2  2B C0                          SUB     AX,AX
01E4  B9 000C                        MOV     CX,12
01E7  BA 02C0                        MOV     DX,CLOCK                ;CHIP BASE PORT ADDRESS
01EA  8D 36 0054 R                   LEA     SI,UHR                  ;SOURCE=CHIP TABLE WE'VE SET UP
01EE  AC                  DMPIT:     LODSB                           ;MOVE DATA TO AL
01EF  51                             PUSH    CX                      ;NEXT ROUTINE TRASHES COUNTER
01F0  E8 0142 R                      CALL    HEX_DEC                 ;CHANGE TO BCD
01F3  EE                             OUT     DX,AL                   ;"WRITE" TO CHIP
01F4  42                             INC     DX                      ;NEXT PORT
01F5  59                             POP     CX
01F6  E2 F6                          LOOP    DMPIT                   ;LOOP 'TIL DONE
01F8  C3                             RET
01F9                      SET_CLOCK          ENDP
                          ;
01F9                      LOAD_TICKS         PROC    NEAR            ;LOAD TIME INTO CHIP STRUCTURE FORMAT
01F9  8D 36 0036 R                   LEA     SI,CLK_TBL[2]
01FD  32 E4                          XOR     AH,AH
01FF  AC                             LODSB
0200  A2 0057 R                      MOV     UHR.MINS,AL
0203  AC                             LODSB
0204  A2 0058 R                      MOV     UHR.HRS,AL
0207  AC                             LODSB
0208  A2 0055 R                      MOV     UHR.HUNDS,AL
020B  AC                             LODSB
020C  A2 0056 R                      MOV     UHR.SECS,AL
020F  C3                             RET
0210                      LOAD_TICKS         ENDP


                          ;
0210                      UNSCRAM    PROC    NEAR                    ;DAYS SINCE 1/1/80 TO MM/DD/YY
0210  8D 2E 0034 R                   LEA     BP,CLK_TBL
0214  2E: 8B 46 00                   MOV     AX,WORD PTR CS:[BP]     ;FIRST WORD IN CLK_TBL
0218  3D 0000                        CMP     AX,0                    ;IF IT'S 1-1-80, TAKE SHORT CUT
021B  74 67                          JE      U4
021D  BB 016D                        MOV     BX,DAYS_YR
0220  99                             CWD                             ;BLANK OUT DX FOR DIVIDE
0221  F7 F3                          DIV     BX                      ;YRS GO TO AL, DAYS LEFT TO DX
0223  A2 005E R                      MOV     UHR.YR,AL               ;SAVE YRS SINCE 1980
                                                                     ;NOW CHECK WHETHER LEAP DAYS OR END OF
0226  E8 0151 R                      CALL    LEAP_CHK                ;     YEAR HAVE MADE IT LOOK LIKE A NEW YR
0229  2B C9                          SUB     CX,CX
022B  8A 0E 0061 R                   MOV     CL,NUM_LEAPS
022F  3B D1                          CMP     DX,CX
0231  7F 0E                          JG      OK                      ;IF REMAINDER DAYS<LEAP DAYS, FIX IT
0233  81 C2 016D                     ADD     DX,DAYS_YR
0237  FE 0E 005E R                   DEC     UHR.YR                  ;ALL FIXED NOW
023B  A0 005E R                      MOV     AL,UHR.YR               ;REDO LEAP VARIABLES
023E  E8 0151 R                      CALL    LEAP_CHK
0241  33 DB               OK:        XOR     BX,BX
0243  8A 1E 0061 R                   MOV     BL,NUM_LEAPS
0247  2B D3                          SUB     DX,BX                   ;CORRECT FOR LEAPS
0249  F6 06 0060 R 10                TEST    LEAP_STAT,10H           ;CURRENT YEAR A LEAP?
024E  74 0E                          JZ      U0                      ;JUMP ON NO
0250  83 FA 3C                       CMP     DX,DAYS_FEB29           ;AT/BEFORE FEB 29?
0253  7E 09                          JLE     U0                      ;YES -JUMP
0255  C6 06 005F R 02                MOV     UHR.LEAP_BK,YES_CODE    ;SET RAM SWITCH TO 'YES'
025A  4A                             DEC     DX                      ;NO - TAKE OUT THAT EXTRA DAY
025B  EB 06 90                       JMP     U1
025E  C6 06 005F R 01     U0:        MOV     UHR.LEAP_BK,NO_CODE     ;SET RAM TO 'NO'
0263  BB 001A             U1:        MOV     BX,26
0266  8D 3E 003A R                   LEA     DI,MON_TBL
026A  83 EB 02            U2:        SUB     BX,2
026D  39 11                          CMP     WORD PTR [DI][BX],DX
026F  7D F9                          JGE     U2                      ;FIND RIGHT MONTH IN TABLE
0271  2B 11                          SUB     DX,WORD PTR [DI][BX]    ;DAYS INTO MONTH LEFT IN DX
0273  D0 CB                          ROR     BL,1
0275  FE C3                          INC     BL
0277  88 16 005A R        U3:        MOV     UHR.DAY,DL
027B  88 1E 005D R                   MOV     UHR.MON_CHK,BL          ;SET UP MONTH VERIFY IN RAM TOO
027F  88 1E 005B R                   MOV     UHR.MO,BL
0283  C3                             RET
0284  B2 00               U4:        MOV     DL,0                    ;SET UP FOR 1-1-80 "in the beginning..."
0286  B3 01                          MOV     BL,1
0288  C6 06 005E R 00                MOV     UHR.YR,0
028D  EB E8                          JMP     U3
028F                      UNSCRAM ENDP
                          ;


                          ;      D E V I C E   S T R A T E G Y
                          ;
028F                      DEV_STRATEGY:
```

Listing 1 continued on page 448

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Listing 1 continued:

```
028F  2E: 8C 06 0014 R              MOV     CS:RH_SEG,ES              ;SAVE SEGMENT OF REQUEST HEADER PTR
0294  2E: 89 1E 0012 R              MOV     CS:RH_OFF,BX              ;SAVE OFFSET OF SAME
0299  CB                            RET
                             ;
                             ;   D E V I C E   I N T E R R U P T   H A N D L E R
                             ;
029A                         DEV_INT:
                             ;PRESERVE MACHINE STATE
029A  FC                            CLD
029B  1E                            PUSH    DS
029C  06                            PUSH    ES
029D  50                            PUSH    AX
029E  53                            PUSH    BX
029F  51                            PUSH    CX
02A0  52                            PUSH    DX
02A1  57                            PUSH    DI
02A2  56                            PUSH    SI
                             ;
                             ;BRANCH ACCORDING TO THE FUNCTION PASSED
                             ;
02A3  2E: 8B 1E 0012 R              MOV     BX,CS:RH_OFF              ;GET REQUEST BLOCK ADDRESS FROM WHERE
02A8  2E: 8E 06 0014 R              MOV     ES,CS:RH_SEG              ;     DEVICE STRATEGY PUT IT
02AD  26: 8A 47 02                  MOV     AL,ES:[BX]+2              ;GET FUNCTION BYTE
02B1  D0 C0                         ROL     AL,1                      ;GET OFFSET INTO TABLE
02B3  8D 3E 001A R                  LEA     DI,FUNTAB                 ;GET ADDR OF FUNCTION TABLE
02B7  32 E4                         XOR     AH,AH
02B9  03 F8                         ADD     DI,AX
02BB  FF 25                         JMP     WORD PTR[DI]

                             ;
                             ; THE FOLLOWING ENTRIES ARE NOT SUPPORTED BY THIS DEVICE
                             ;
02BD                         IOCTL_IN:
02BD                         IOCTL_OUT:
02BD                         ND_INPUT:
02BD                         IN_STAT:
02BD                         IN_FLUSH:
02BD                         OUT_STAT:
02BD                         OUT_FLUSH:
02BD                         MEDIA_CHECK:
02BD                         BUILD_BPB:
02BD                         OUT_VERIFY:
                                    STATUS  DONE,ERROR,03             ;SET STATUS BYTE AS "ERROR-UNK COMMAND"
02BD  26: 81 4F 03 0100    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0100H
02C3  26: 81 4F 03 1000    +        OR      ES:WORD PTR SRH_STA_FLD[BX],1000H
02C9  26: 81 4F 03 0003    +        OR      ES:WORD PTR SRH_STA_FLD[BX],03
02CF  EB 3F 90                      JMP     EXIT
                             ;
                             ;  INPUT = READ THE CLOCK CHIP
                             ;
02D2                         INPUT:
02D2  E8 0062 R                     CALL    IN_SAVE                   ;CALL THE INITIAL SAVE RTN
02D5  E8 0073 R                     CALL    READ_CLOCK                ;READ IN THAT DATE/TIME
02D8  2E: 8B 1E 0012 R              MOV     BX,CS:RH_OFF              ;RESTORE ES:BX AS REQ HDR PTR
02DD  2E: 8E 06 0014 R              MOV     ES,CS:RH_SEG
                                    STATUS  DONE,NOERROR,0
02E2  26: 81 4F 03 0100    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0100H
02E8  26: 81 4F 03 0000    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0
02EE  EB 20 90                      JMP     EXIT
                             ;
                             ; OUTPUT = SET TIME & DATE
                             ;
02F1                         OUTPUT:
02F1  E8 0062 R                     CALL    IN_SAVE                   ;CALL INITIAL SAVE ROUTINE
02F4  E8 01C4 R                     CALL    SET_CLOCK                 ;SET TIME & DATE
02F7  2E: 8B 1E 0012 R              MOV     BX,CS:RH_OFF              ;RESTORE ES:BX AS REQUEST HDR PTR
02FC  2E: 8E 06 0014 R              MOV     ES,CS:RH_SEG
                                    STATUS  DONE,NOERROR,0
0301  26: 81 4F 03 0100    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0100H
0307  26: 81 4F 03 0000    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0
030D  EB 01 90                      JMP     EXIT
                             ;


                             ;
                             ; EVERBODY'S EXIT
                             ;
0310                         EXIT:
0310  5E                            POP     SI
0311  5F                            POP     DI
0312  5A                            POP     DX
0313  59                            POP     CX
0314  5B                            POP     BX
0315  58                            POP     AX
0316  07                            POP     ES
0317  1F                            POP     DS
0318  CB                            RET
                             ;
                             ;  INIT
                             ;
0319                         INIT:
0319  0E                            PUSH    CS
031A  58                            POP     AX                        ;CURRENT CS TO AX
031B  05 0319 R                     ADD     AX,OFFSET INIT
031E  26: C7 47 0E 0000             MOV     ES:WORD PTR BR_ADDR_0[BX],0
0324  26: 89 47 10                  MOV     ES:BR_ADDR_1[BX],AX       ; MAKE THAT THE BREAK ADDR
                             ;
                             ;CHECK VERIFY BYTE - HAS SOME OTHER SOFTWARE DIDDLED THE CLOCK?
                             ;
0328  BA 02C8                       MOV     DX,CLOCK+VALID            ;PORT FOR VERIFY RAM
032B  EC                            IN      AL,DX
032C  3C 10                         CMP     AL,VALID_CODE             ;ARBITRARY VALIDATION CODE
032E  74 0E                         JZ      FINE                      ;JUMP ON OK
                             ;
                             ;RESET CHIP-CAN'T TRUST IT
                             ;
0330  B0 FF                         MOV     AL,0FFH                   ;RESET ALL REGISTERS
0332  BA 02D2                       MOV     DX,CLOCK+COUNTER_RESET
0335  EE                            OUT     DX,AL                     ;RESET ALL COUNTERS
0336  42                            INC     DX                        ;RAM(LATCH) RESET ADDR
0337  EE                            OUT     DX,AL                     ;NOW RESET RAM
0338  B0 10                         MOV     AL,VALID_CODE
033A  BA 02C8                       MOV     DX,CLOCK+VALID            ;NOW VALIDATE RAM
033D  EE                            OUT     DX,AL
                             ;
033E                         FINE:  STATUS  DONE,NOERROR,0
033E  26: 81 4F 03 0100    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0100H
0344  26: 81 4F 03 0000    +        OR      ES:WORD PTR SRH_STA_FLD[BX],0
034A  EB C4                         JMP     EXIT
034C                         CLK    ENDP
034C                         CSEG   ENDS
                                    END     BEGIN
```

Text continued from page 443:

The DOS manual warns that heavy stack use might require a separate stack, however.

When initialized (INIT), the driver must tell the DOS the ending address of its code. PC-DOS 2.0 allocates all available memory to a program unless it is told otherwise, and failure to indicate an end causes quite a hang-up. This feature also allows disposable initialization code and attendant memory conservation.

When finished, the driver sets appropriate bits in a STATUS word located in the Request Header.

The Hardware

Normally, when the system is booted up, the PC starts counting timer ticks and uses software in the ROM (read-only memory) BIOS (basic input/output system) and disk system files to keep track of the time and date. You can set both, but the machine obviously has no memory of either when switched off. Many manufacturers are now supplying real-time clock/calendar chips with on-board battery backup.

Software is supplied to access the chip and set the time and date at start-up. AST Research supplies two programs at present to service the MM58167A chip. One reads the chip and sets the system time/date, and one sets the chip functions.

The MM58167A chip provides the time, day of the week, day of the month, and month, with capabilities for alarm features and synchronized start-up for precise timing. All data is stored on the chip in binary-coded decimal (BCD) format. Unfortunately, as shown in figure 2, PC-DOS 2.0 requires data from the system CLOCK$ in a somewhat different format. Not only does it want the count of days since 1-1-80, but it also wants it in hexadecimal. The chip has no provisions for handling leap years or for keeping track of the year in any manner. Hidden in PC-DOS 2.0 are some appropriate algorithms for doing all this, but our driver reinvents the wheel and gives the PC-DOS 2.0 the raw hexadecimal data.

In addition to the counters on the clock chip, a bank of programmable latches also can be used as a nonvolatile RAM for storing the year, keeping track of leap-year bookkeeping, and checking to see if some other software has violated the clock or reset it. Much of the clock-driver program is devoted to these tasks. Other pertinent registers on the chip are a status register that indicates an invalid read due to counter rollover and registers to reset the counters and clear the RAM. All of these registers and counters have discrete I/O port addresses beginning at the base clock-port address hexadecimal 2C0 and ending at hexadecimal 2C0 + 1F.

It appears that most other real-time clock chips work in a similar fashion, storing data in BCD. This driver can be adapted to other boards by changing the appropriate base-port address and chip structure (provided it gives you a place to hide control bytes in nonvolatile RAM).

The Software

At the beginning of listing 1, the program makes use of two features of the macroassembler to make the

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Word (0–1)	number of days since 1 January 1980
Byte (2)	minutes
Byte (3)	hours
Byte (4)	1/100ths of a second
Byte (5)	seconds

Figure 2: *PC-DOS format requirements for date/time transfer with the National Semiconductor MM58167A Real-Time Clock chip.*

program easier to write and more readable. The STATUS macro borrowed from IBM helps by managing the setting of the status bit in the Request Header. It is expanded during compilation into the appropriate one or two lines of code. If the DOS should ever call on the clock for something inappropriate, like building a BIOS parameter block, the expanded STATUS macro will return the proper error code.

The STRUC (structure) pseudo op code generates no machine code directly but permits easy allocation of storage space and data access. The CLOCK_PORTS structure is set up to manipulate data the way the I/O ports line up on the chip. The UHR table of variables is set up according to this structure. The field names used act as mnemonics for offsets. For example, the value of the hours read into or written from the table is merely UHR.HRS. Similarly, [BX].HRS would return the value in memory located at the address in BX plus an offset of four. Structures also can be initialized at execution time to any value you choose, although here I've left it indeterminate.

After the required Special Device Header is the storage area of the program. This so-called data segment contains pointer storage, a function table for calculating what the DOS wants, local data storage such as UHR, and a month table. This table is used to transform the number of days to a month-day-year format and back again. It would be nice to use the 8088's XLAT op code for table lookups here but, unfortunately, XLAT translates only bytes, not words. The 8086 also suffers from this limitation.

Several of the subroutines are called many times. DEC_HEX and HEX_DEC convert packed BCD numbers back and forth to hexadecimal. LEAP_CHK checks to see if the current year is a leap year, computes corrective leap days to add or subtract from the count, and sets local variables to indicate its findings (LEAP_STAT and NUM_LEAPS). NEW_YEAR compares the current month to a month-check byte stored in RAM on the chip. It updates the latter if necessary and handles the rollover to a new year. DAYS_MONTH (in lieu of XLAT) returns with BX pointing in the MON_TBL to the number of days in a year up to the current month.

Reading or setting the time portion of the clock is a simple pass-through of data, but special routines handle the date. DAYS reads the date and puts it into the DOS format; UNSCRAM does the opposite. The year minus 1980 is stored in RAM. During leap years the chip thinks February 29th is March 1st. In this case, LEAP_ADJ resets the chip and also writes code into its RAM to signal that it has been done.

Is It Worth It?

Are all of the new features of PC-DOS 2.0 worthwhile? I don't think a two-disk-drive PC owner will have missed the boat by continuing to use version 1.1. If you have a hard disk, however, or are contemplating special applications such as remote modem control, data acquisition, or writing your own command processor, PC-DOS 2.0 is the only way to go.■

For those who prefer to let someone else do the typing, a 5¼-inch PC-DOS disk with the source code, CONFIG.SYS examples, and a COM version is available from the author for $15.

David K. Broadwell, M.D. (135 Hospital Dr., Angleton, TX 77515), is a specialist in internal and aviation medicine. An instrument-rated pilot, amateur radio operator, soccer fan, and IBM PC user, he has his sights set on becoming an astronaut.

BYTE's User to User

Conducted by Jerry Pournelle

Bypassing FIELD

Dear Jerry,

In "Eagles, Text Editors, New Compilers, and Much More" (September, page 307), you mention Microsoft BASIC and make a passing reference to its FIELD statement. The FIELD statement can be almost completely bypassed if you simply ignore the way they say to use it. I always define one and only one variable in a single FIELD statement for any MBASIC "R" file. I define the variable to be the size of the entire file buffer—since the buffer is limited to 128 bytes. Unless you're using a parameter when loading MBASIC from CP/M, there is no problem about string sizes. This avoids the problem of numerous string variables that would result from following Microsoft's directions. It also allows more flexibility. The same field is used even for records with different contents. For example, in ephemeris files, my first record is two integers and a double-precision number (12 bytes), and all later records are three single-precision numbers (12 bytes). Or, a more complex record occupying five 128-byte sectors—one FIELD of 128 bytes is all it takes.

It works this way: the manuals warn you never to use normal string operations on FIELDed variables—the actual restriction is never use normal assignments. You can use LEFT$, MID$, and RIGHT$ to read FIELDed variables. For assignments, what I do is build up my record using string concatenation with a throwaway string variable, then use LSET to put it in the buffer variable. The MKI$, MKS$, and MKD$ functions will work with any string variable—they are not restricted to buffer variables. Similarly, the CVI, CVS, and CVD functions will accept substrings extracted by LEFT$, MID$, and RIGHT$.

Is it at all likely that there will ever be an 8086 version of Write?

Mark Pottenger
838 5th Ave.
Los Angeles, CA 90005

That's certainly one way to deal with the dreaded FIELD statement.

An 8086 version of Write is in preparation now. It had better be, since I'm not going to stay with a Z80 forever! If Tony doesn't get it done pretty soon, I'll write my own version in Modula-2. . . . **Jerry**

A Doc's Best Friend

Dear Jerry,

A comment from a practicing physician on the Problem-Knowledge Coupler (dubbed Auto-Doc in "New Computers, Boards, Languages, and Other Tidbits," October, page 107): I want one. It will sure reduce my malpractice exposure. This is especially true for psychiatrists like myself. For example, I had a hunch that a foreign service officer's depression was actually an infection with a parasite. He had to wait until he was transferred to Southeast Asia to get it diagnosed. (National Institutes of Health was no help.)

I treated another case of depression with a diuretic. After her first visit, she didn't need me anymore. It turns out that asymptomatic mild congestive heart failure can cause depression.

The point is this: Many physicians today are specialists, and specialists perforce have limited experience outside their specialties. We need something to extend our experience. In medical school, we all carried pocket notebooks crammed with salient information which we had not yet or never would memorize. We called them "peripheral brains." I think the extension is obvious and should be welcomed.

Ed Hume
Washington, DC

An excellent point. It would be surprising if psychiatrists could keep up with new developments, or even remember all they once knew about internal medicine. Dr. Weed's Problem-Knowledge Coupler (PKC) should be a real boon to the medical specialist—not to mention to the patient. I hope to have more about his diagnostic programs in an upcoming issue. . . . **Jerry**

Languages of the Future

Dear Jerry,

I agree that none of us has a completely unclouded crystal ball, but I am surprised at some of the conclusions you have arrived at in your article "The Debate Goes On . . ." (August, page 312). I would have thought that both of us are in the same business, futurism, but for different reasons. You for the purpose of writing entertainment fiction, and me for making investment recommendations. Still, your conclusions seem to ignore existing technology, let alone what seems to be coming over the horizon.

If you consider the Apple II, TRS-80 Model III, and the like, all first-generation microcomputers, then the IBM Personal Computer should be considered a late first-generation microcomputer. The Apple Lisa is the beginning of the second generation. The Motorola 68000 microprocessor in the Lisa is capable of addressing something over 11 megabytes (MB) of memory and Motorola promises a 32-bit version of that chip "soon" that would address 32 MB.

According to the trade announcements, upcoming 256K-bit memory chips will use CMOS technology that will make them usable for permanent or at least semipermanent storage, ending the distinction between RAM and ROM memory. Therefore, if you consider only existing technology and past price-curve performance, the magnetic-storage media manufacturers will be the buggy-whip makers of the mid-to-late 80s.

The answer to your question of which high-level language will prevail over the next five years is none of those you mentioned, or indeed, any high-level language as they are now recognized. Large memories will bring along self-programming computers that will program in machine language. Machine language would be our answer now, except it remains too difficult for most of us to learn and implement. The next 10 to 15 years will see microcomputers with enormous memories, probably multistate, which would be beyond human ability to program in any event. We may not see Arthur Clarke's HAL by 2001, but we seem to be on the road.

Adolph L. Friedman
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I thought I'd said that within five years, the floppy disks will be relegated to their original role of data transfer. Certainly I agree that with memory getting both cheaper and less volatile, we'll see some revolutionary developments in mass storage.

Regarding languages, perhaps; although five years is, I think, too short a time limit.

VAX and LISP machines aren't yet self-programming even in graduate schools of computer science; I'm pretty sure my desk micro won't be that smart by 1990, which is stretching past the five years of my article anyway.

Certainly, though, that's what some of the artificial-intelligence troops are working toward, and I expect we'll both live to see it. . . . **Jerry**

Defending FORTH

Dear Jerry,

I was excited to see a special article on microcomputer languages ("The Debate Goes On . . .," August, page 312). As a language hacker, I am familiar with most of the languages you mentioned, plus a few others. Much of what you wrote was timely and probably accurate. I must, however, take exception to your comments on FORTH and LISP.

You seem to be misinformed on both languages, yet you claim knowledge of both. As I am most familiar with FORTH, let me set you straight on the subject (I'm sure you'll get plenty of mail from all the LISPers).

For one thing, LISP will *never* absorb FORTH. The two languages are too different. Each has its place in the scheme of things. LISP, which is modeled after the lambda calculus, was created in the bowels of the MIT artificial-intelligence labs. Its purpose is to give experimenters in AI the tools to go about their trade. FORTH was invented by Charles Moore to provide the tools necessary for machine control and data collection. In this light, Moore's aim was to provide speed, efficiency, and productivity.

Looking at the environments of the two languages does reveal similarities. Both systems are compiled and then interpreted at run time. Both are implemented in an interactive environment and both look cryptic to the uninformed observer (LISP especially so).

If one looks a little closer, though, it becomes apparent that the two environments are totally different. FORTH is exceedingly small and very fast. On most microcomputers, FORTH's inner interpreter is only a few bytes long. The code generated by the FORTH compiler is very compact (even more compact than assembly language). One can strip out the parts of the system that aren't needed to make the code even more compact. This makes it possible to generate tight, ROMable code. With FORTH, real-time, interrupt-driven applications are easy because the language is modular and close to the hardware. Many applications use these features to great advantage. The Craig Language Translator was programmed entirely in FORTH, as are a lot of coin-operated arcade games.

Hardware developers use FORTH because it is a very productive environment to work in. FORTH's modularity, extensibility, and virtual memory make it a hotbed for development. Recently, much is being said for developing business applications in FORTH. This is where FORTH's virtual memory can strut its stuff. Plus, the tools developed for one application can be transported to another with little or no change.

Much of the early problems with transportability of FORTH is being addressed by an international standards team composed of FORTH programmers. This gives the assurance that a standard transportable language will exist. And because FORTH is an evolving language, obsolescence is not in its future.

FORTH integrates extremely well into the microcomputer environment. Its advantages of speed and memory efficiency make it an almost ideal language for the small computer. (The Motorola 6809E is almost a FORTH machine in silicon.) For large systems, FORTH is at home as well. Multitask and multiuser primitives are easily added to the system. As a bonus, multiuser FORTH code is inherently reentrant.

Now, tell me again how LISP will absorb FORTH. As a reference to learn about each language, you may want to look at August 1980 BYTE for FORTH and August 1979 BYTE for LISP. And please try to be more informed before making rash statements like this.

Arne W. Flones
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Wichita, KS 67203

Thank you. You speak well for FORTH. Perhaps I was a bit strong. However, what I said was, "I suspect that as LISPs get more common, LISP will get the bulk of the recruits who would otherwise have gone to FORTH." I was careful not to say that FORTH would vanish.

I'm still not certain that I was mistaken. True, the two languages are different; but as hardware evolves and computer power becomes cheaper, our desk machines will look more like the big machines available in computer labs and universities.

I think LISP is more popular with computer scientists than FORTH is. It certainly is at MIT and Stanford (and my friendships at those two institutions probably do influence my thinking). Thus more students are likely to be exposed to LISP than FORTH, and are thus more likely to use it. Recall also that when I say "popular," I mean in the context of microcomputer sales: 30,000 to 300,000 machines a month. *Given those sales, even "unpopular" can translate to a heck of a lot of users!*

In any event, alas, I don't know either LISP or FORTH. However, experts on both have offered me tutorials. One day I'll have time to accept. . . . **Jerry**

Heathkit Horror

Dear Jerry,

I recently purchased a Heathkit H-100 computer. It has two floppy disks, 192K bytes, color graphics, color monitor, etc. My decision to buy the H-100 was influenced by several factors. The 16-bit word was a must. The advertised repair facilities at the Heathkit Electronic Centers were very important. Price was a consideration. Most important was the Heath-advertised assurance "And every step of the way, you have our pledge—We won't let you fail. Help is as close as your phone or the nearest Heathkit Electronic Center."

In the past, I have built several kits. This time, however, while building the disk-controller board I managed to get the wrong part in the right hole (or vice versa). Attempting to get it out I damaged the board. My fault, so I have no complaint there.

Remembering the glowing "We won't let you fail" message, I went trotting down to the local Heathkit center. There the local electronics guru agreed the board was damaged. However, it did not appear to be beyond repair.

For an additional fee of fifty dollars, the local Heathkit center sent the board back to the factory for "reconstruction." So far so good. For a price, Heath seemed to be living up to its representations. Not what I expected, but better than nothing.

Now the problem. This is the seventh week since the board was sent in. The local Heathkit center doesn't know when it will be returned. They somewhat apologetically offer assurances that they will call as soon as it comes back.

My concern is that I have paid Heath close to $4000 for hardware and software. To date, it has been sitting on the shelf. If there should be a second problem, will that take another two or three months or longer? When they say "We won't let you fail," do they really mean that if you make a mistake, it will probably be several months before you can use your computer?

What about maintenance? I bought the computer because I have a real need for its use. If it breaks, do I look forward to a two- or three-month delay for Heath to provide repairs? If so, how do I produce my letters, documents, manuals, mailing lists, etc? What happens to accounts receivable, accounts payable, etc? Do I go back to a manual system?

At this point I have serious concerns about the wisdom of my purchase. The implied support does not seem to be as represented.

I also have serious concerns about inexperienced people who attempt to assemble one of these. Quite often the assembly instructions leave a great deal to the imagination. In my opinion, no one should attempt one of these without a basic understanding of electronics, some degree of manual dexterity, and considerable experience assembling and soldering boards. Unless, of course, he is willing to pay the extra charges and put up with the extended delays which seem to be part of the "We won't let you fail" assurances from Heath.

Richard J. Townsend
35 Charles Hill Circle
Orinda, CA 94563

Yours is about the worst horror story I've ever heard about Heathkit. Most of my correspondents have been very pleased with the H-100, finding it simple to build and get running; and I've never before heard of so long a delay in getting service.

I do agree: you must be very careful about soldering. It's easier than you know to wreck one of those multilayer circuit boards. (I recall when Jim Hudson modified my Compupro 8085/8088 board to change the crystal; he was not only very careful, but he was worried about changing it back when the time came.)

I'd advise anyone contemplating construction of something as complex as an H-100 to buy a really good temperature-controlled soldering iron, and also one of those patented unsoldering devices. The two will cost nearly a hundred dollars, but it's good insurance.

Incidentally, all the Heath/Zenith stores use Heath and Zenith machines to record and report the sales, so the company obviously has some confidence in the machines. . . . **Jerry**

Otrona Obstacle

Dear Jerry,

The last two paragraphs in "Ulterior Motives, Lobo, Buying Your First Computer, JRT Update" (May, page 298) caught my attention. As you may know, there are a significant number of Otrona Attaché machines and users (as well as fellow enthusiasts) here at the lab. However, I have not been able to find anyone who can make the BIOS digest what ought to be valid ''9'' entries in the Otrona Attaché's escape sequences. For example, try to plot a point at $(x,y) = (9,9)$ from the keyboard or assembly-language calls with ^[0^A^I^A^I or from MBASIC with PRINT CHR$(27); "00909". In contrast, the user-friendly MBASIC plotting enhancements work without a glitch. Unfortunately, I need to run FORTRAN (F80, M80, and L80). The enclosed list is not exhaustive since I also suspect the alternate lead-in^ [V command. The use of more offsets might help some escape commands but others require parameters with a range from 0 to 255.

Would any of your friendly wizards (hackers or consultants) happen to have a general idiot-proof patch around this turkey? Several sources indicate that the problem relates to the interface with CP/M's Tab function. I would appreciate any advice on this matter (or especially a cookbook solution).

Glenn Veeder
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Dr.
Pasadena, CA 91103

Alas, you have exceeded my competence; but perhaps one of the readers will have a solution to your problem. I know of at least one Nobel physicist who has an Otrona, and who greatly enjoys playing about with its insides, as well as a number of computer professionals. You may also want to contact FAUG, The First Attaché Users Group at 449½ Douglass St., San Francisco, CA 94114, or call (415) 647-8160. . . . **Jerry**

Move That Key!

Dear Jerry,

Regarding "Epson QX-10, Zenith Z-29, CP/M-68K, and More" (August, page 434), I have purchased the Z-29 terminal and like it. However, note the *terrible* placement of the Reset/Break key—right amongst several oft-used keys. If the Break does anything at all in a system, it does something drastic. I had to modify my BIOS to keep my system from going catatonic on Break. Heath/Zenith ought to move that key. You'd think everyone would have learned by now about placement of Break keys.

When is one of your generous friends going to put together a technically oriented word-processing system—one that will do special symbols (math, Greek, etc.), superscripts and subscripts, and the like, with a screen display that looks like the printed result? Epson is coming close. Why are the Japanese ahead of us again? All the printer and screen-display technology exists. Why can't it be put together? Or do I have to program it myself?

H. Bradford Thompson
The University of Toledo
2801 West Bancroft St.
Toledo, OH 43606

Fortunately, you must do Control-Reset for the Reset key to do anything. I do agree that was a silly place to put it. I've never had any trouble with the Break key, but, as you mention, you can always jigger the CBIOS (Customized Basic Input/Output System) to take care of it; indeed, you can retranslate the key if you really want to.

The Zenith Z-100 with the MPI 150G printer can do what you want; that is, the printer can print exactly what's on the screen. Of course, programming the special character set you want can be a problem. A good matrix printer, like the MPI, in conjunction with the Otrona Attaché does wonders too; the Attaché has Greek letters and various mathematical symbols built into its secondary character set.

Meanwhile, it's the Europeans who are really ahead. Niklaus Wirth's Lilith computer (available with laser printer in the U.S. from Diser Corporation for about $30,000) can do all you ask for and a lot more besides; and with Modula-2 systems becoming available pretty inexpensively here, you should be able to program what you want for any good 8086 and high-quality dot-matrix printer. Let me know when you get it done. . . .

Seriously, you raise an important point. Why hasn't a U.S. company put it all together? Or have they, and I haven't seen it yet? . . . **Jerry**

I'll Take Your Epson

Dear Jerry,

According to your response to Chris Rutkowski's letter in BYTE's User to User (September, page 480), your Epson QX-10

programmer s

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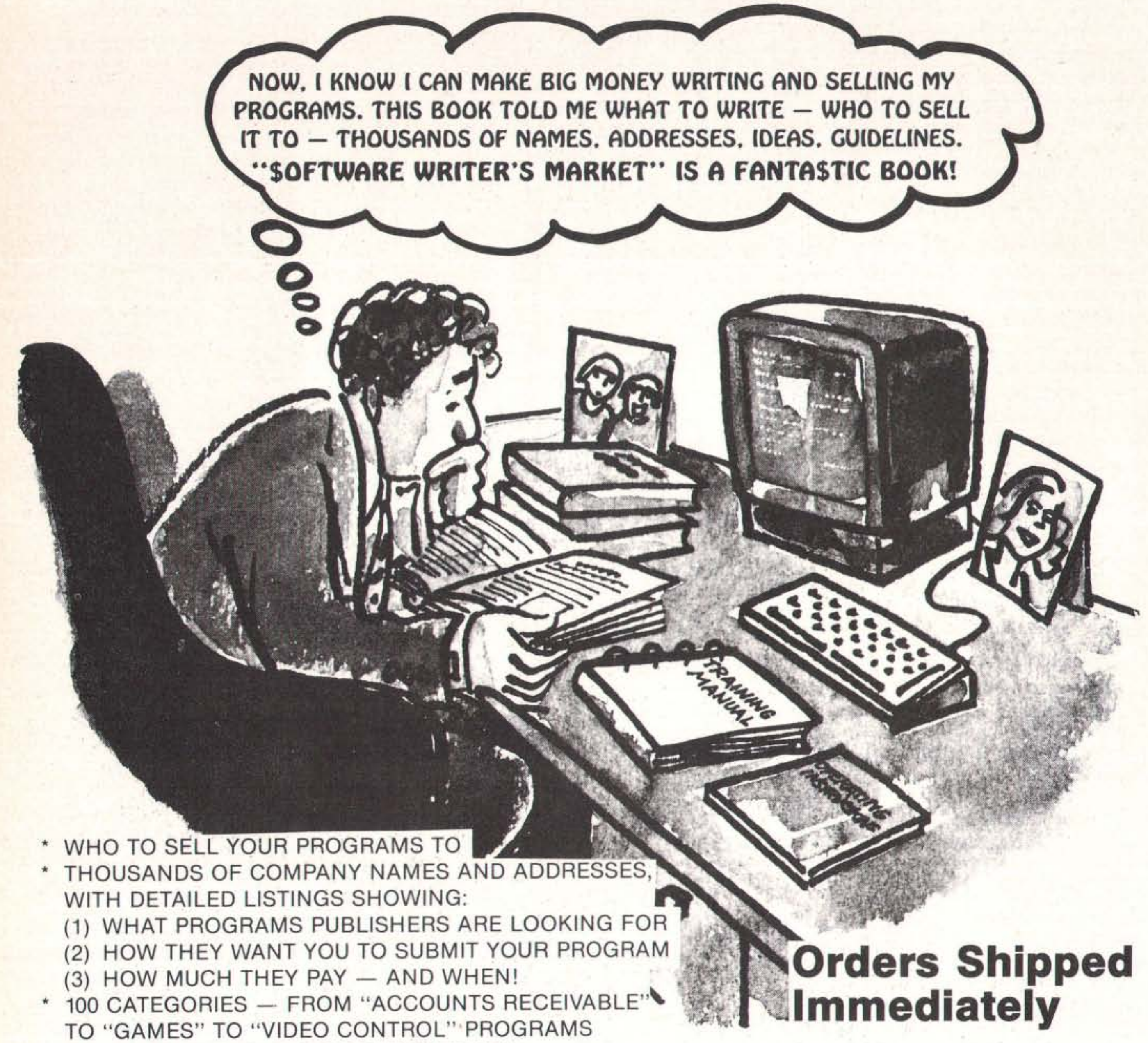

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has been pretty much abandoned. I would like to suggest that you pack it up and send it to me! As a computer novice, I am not a fast typist, nor am I experienced with fast, powerful systems like the ones you routinely deal with. I feel the QX-10 is a great little machine, but have been unable to fund its purchase.

When I read of your ongoing disillusion with your Epson, going from one associate to another only to be abandoned by one and all, I thought I would at least write you this letter, to let you know that a home for orphan computers can be found. It would be well treated and much appreciated in our home.

It may be that many of the inherent problems with regard to operating systems will eventually become a great nuisance to us as we become more skilled in computers, and we may be financially able to move to a new and better S-100 system. If so, I promise to pass the Epson on to someone at no cost. We could be starting a great tradition here.

Jim Ralph
987 Lovers Lane
Akron, OH 44306

I guess I'd better explain what happens to review equipment here. None of it ever belongs to me. Some of it gets kept so long that it's functionally useless before we get through with it. This is often true of prototype equipment. Some is returned to the supplier. (The less we like it, the faster it goes back.) Some, at the request of the supplier, is donated to educational nonprofit institutions (and I have a long list of eligibles, so there's no point in applying for your favorite; sorry).

As for the Epson, we're not at all through with it. It's a nifty machine, and they're developing software worthy of it. As Professor Thompson points out in the preceding letter, there's nothing in the microcomputer world that comes closer to integrating screen and printout graphics. If we were truly *unhappy with the QX-10, we'd have sent it back long ago. . . .* **Jerry**

Choosing a Terminal

Dear Jerry,

I have been following your trials and tribulations relating to finding the perfect terminal and your choice of a Z-29 is a good one. I borrowed one from my "mad" furloughed friend and attached it to my North Star Horizon.

I am also in the market for a new terminal to replace my 7-year-old ACT-V. I want high-resolution graphics capabilities, so I have been leaning toward the Visual 500. The Visual terminals seem to be very well designed and I especially like the extra-thin keyboard and choice of 12- or 14-inch screens. The Visual 50 is more in the league of the Z-29 as far as emulation and price (less than $600 from some distributors). Have you ever considered the Visual terminals and, if so, what caused you to choose the Z-29 over them?

I know that you have used solid-state disk drives and are pleased with their performance. I would like to obtain one, but the price has prevented me. Have you ever tried a less expensive drive? One is sold by Digital Research Computers, $399 for a 256K kit, or less than half the price of the newly reduced Semidisk at $995.

James A. Whitman
Rt. #1 Box 408
Ft. Ashby, WV 26719

I seem to be batting zero. I've no experience with the Visual 500. As to how I chose the Z-29, I blush to confess that Zenith asked me to. There was a time when I could try out most of the new micro equipment; now that's not possible. I try to keep up by going to shows and reading the literature, but it's still pretty overwhelming.

Building kits is not my particular bag. I gather that if you're of a patient temperament, and willing to invest in a good temperature-controlled soldering iron, you can save a lot of money. There was a time when the best micro equipment was built from kits. My late friend Ezekial, who happened to be a Z80, was built up from kits (although not by me), because Tony Pietsch was more confident of his quality-control procedures than those of the company who made Zeke.

Nowadays, though, there's a lot of well-made equipment out there. Years ago, I once proposed building my own terminal so that I would understand what was in it. My mad friend put it succinctly: "Sounds like about as much fun as an appendectomy." Thus, I can sympathize with your desire to save money, but I won't be the one to recommend that you turn to kits. Perhaps another reader will have a comment. . . . **Jerry**

Protecting Pac-Man

Dear Jerry,

Hello from down-under (personally, I don't like that term . . . unless you like being called up-over).

In "The User Goes to the Faire" (June, page 306), you mentioned your participation in the Star Wars vs. Battlestar Galactica dispute and the question arose of what constitutes an idea worthy of protection. Taking the Pac-Man example, surely the essential ingredient of this game is the theme of a player navigating a maze and consuming power pods. The shape of the Pac-Man or the nature of the power pods is irrelevant to the underlying theme of the game. Thus there are two views one could take.

First, the people who originally conceived the Pac-Man theme, Atari, should have sole and complete rights to its implementations. The public would have to rely on Atari to produce the different versions of this popular game, or just put up with the standard format. Intrepid programmers could of course write their own versions, as long as they'd recognize Atari's claim to part or all of any profits gained. Second, all ideas are unique (and not just one of genre). This would mean that the slightest difference in the shape of the Pac-Man would constitute a new idea. The public reaction to the multitude of different games resulting from this policy would indicate who had the best idea. This policy allows constant improvement of existing merchandise and a good climate for the small business.

I only offer these as possibilities for the resolution of a persistent problem, and do not make a judgment as to their quality. I do however feel strongly that the present situation, by which many Pac-Man games are legal but some, which most *resemble* the original, are sued, is totally unjust and impractical.

Brett A. Patterson
26 Athlone Rd.
Floreat, 6014,
Perth
Western Australia

I'm not sure what *I think about protecting Pac-Man. I do know that Atari bought itself about a million dollars worth of unfavorable publicity by bullying some very nice teen-aged programmers; surely they could have been smoother about it. Game fads don't last long anyway. I notice that what really gets 'em in the arcades now are the games coupled to video disks; these, I fear, are not soon likely to be produced in garages, although I wish they were. I've yet to get close enough to a machine to play Dragon's Lair. . . .* **Jerry**

A Vote for Larger Screens

Dear Jerry,

After a year's reading and research we decided to buy either two Kaypro 11's or a NEC APC; we will probably buy the two Kaypros on the theory that if one goes down we have a spare, for the price of one more-advanced computer.

Despite all the amazing progress in computers, and despite the much advertised and vaunted spreadsheets, computers still only show a miserable 24 lines by 80 columns. How silly!

Like every business we use an 8½- by 11-inch sheet for most paperwork. We print booklets, and have been composing them on the typewriter as we write them. All computer salesmen say that it is better to be limited to the small-sized screen, but we don't believe it. We need to view the finished page so that we can see paragraphs in relationship to each other and to see if our ideas are presented correctly on the whole page.

If we had the money we could get a Vydec which shows two full pages, or a Dictaphone which shows one full page with an additional lighted line as is on our Olivetti ET221, or we could go to a Corvus Concept computer, but even that is too high for our budget. The Corvus is the way that the future lies, of course. It puts the CRT on its side for spreadsheet (a 14-inch screen) and on edge for a full page of typing. Why can't some of the other computers do this too at a reasonable price? It can't be too difficult and it is ridiculous to have all these fabulous advances with such a small screen. That is like having a 1983 car that you have to hand-crank!

S. E. Millar
POB 1
Olympia, WA 98507

I fondly remember Olympia; my wife used to race sports cars at Shelton, Washington, and we'd stop for the lumberjack's breakfast on the way.

Tony Pietsch has always said that the best service policy is another computer, preferably identical to your first. It's not much more costly than a long-term maintenance contract, and certainly more useful as long as both are running.

I keep hearing rumors of terminals that will give a great many lines to the page, but I've never had one to play with and, to tell the truth, I've never missed that feature.

I've never had much problem with screen sizes. A standard manuscript page is 60 characters wide, and double-spaced I used to get only 26 lines to the page anyway. In fact, I normally write on a memory-mapped screen that's only 16 lines. My editors tell me it improves my stuff since I don't tend to write such long paragraphs. (Of course I use Write, which uses all the screen lines for text; none are taken up with status lines and things like that.)

I suspect you won't have to wait long before new, low-cost terminals appear with the features you want. Things flow so in microland! . . . **Jerry**

MS-DOS for the Compupro

Dear Jerry,

I have been anxiously awaiting an issue of BYTE in which you review the MS-DOS operating system for the Compupro ever since I followed your eminent logic and purchased a Compupro System 8/16 Model A in December of 1982. Before taking the plunge I did check to find out if MS-DOS was available for the Compupro because I was aware that there was a growing threat from the IBM PC and PC-DOS. I had a hint from two independent sources in BYTE that MS-DOS was available for the Compupro systems. One was a series of articles in BYTE comparing MS-DOS and CP/M-86, written by Roger Taylor and Phil Lemmons ("Upward Migration, Part 1: Translators," June 1982, page 321 and "Upward Migration, Part 2: A Comparison of CP/M-86 and MS-DOS," July 1982, page 330). Careful examination of their articles revealed that the benchmarks were run on Compupro equipment. The other source was a What's New? product blurb in BYTE which stated that Lifeboat Associates would be releasing SB-86 for Compupro systems. I called Compupro and was told: yes, Real Soon Now.

I have since called Lifeboat and the person who configured SB-86 for the Compupro systems has left without documenting the implementation. Yes, as a service, Lifeboat will sell you SB-86 for Compupro but it is not documented and you are pretty much on your own.

Fortunately, I have also discovered two other possible sources. One is Midwest Micro Warehouse which claims to have a product written by people at Compuview Products. Another source is a Computer House product aptly named MS-PRO.

In "Eagles, Text Editors, New Compilers, and Much More" (September, page 307), you indicated that you and/or your associates have experience with MS-DOS/PC-DOS for the Compupro. (I should point out that I am not sure what the exact differences between MS-DOS and PC-DOS are.) I am particularly interested in the logical and/or functional (as opposed to physical and/or implementation) equivalent of PC-DOS. I recognize that this may be a very difficult if not an impossible equivalency to achieve, thus I use the term MS-DOS as a minimal requirement. I would appreciate any additional information or recommendations you may have regarding MS-DOS for the Compupro 8/16 systems.

Chris Boynton
9500 Southwest 94 Court
Miami, FL 33176

I may have misled you, and if so, my apologies. Tony Pietsch has managed to get PC-DOS, the operating system for the IBM Personal Computer, to boot from a 5¼-inch disk run by a Compupro 8085/8088 Dual Processor. The Dual Processor normally boots from 8-inch disks, and runs Digital Research's CP/M 2.2 when in an 8-bit mode (using the 8085) and CP/M-86 when in 16-bit mode. (At least mine does.)

There are no real differences between PC-DOS and MS-DOS, except that PC-DOS is specifically tailored for the IBM PC, while MS-DOS is a generic term for the Microsoft operating system for the 8086/8088 family of computer chips.

Alas, although Tony managed to get PC-DOS to work on his *Dual Processor (and indeed was using* my *disk controller and disks when he did it), he then went off to Europe for a month; as of this moment (October 1), he hasn't returned, and I don't have that operating.*

It's quite possible that what you request will be available by the time this gets in print, but I can't guarantee it. Meanwhile, I have no experience with the other versions you mentioned.

Given the three- to four-month delay between my writing and BYTE's publication, it's always a problem as to just how much brand-new stuff I report. This time, I was a bit eager. Sorry. . . . **Jerry**

Assembly vs. Machine Language

Dear Jerry,

Most of the things you have written for BYTE have been so well informed that I was rather surprised to see your remarks about assembly language in "Eagles, Text Editors, New Compilers, and Much More" (September, page 307).

You say that assembly language is a fairly large step up from machine language. While fairly large is a matter of opinion, it seems to me that because of a one-to-one correspondence between assembly codes and machine instructions, they are in fact different forms of the same language. The only difference is that the assembler mnemonics can be easily remembered by humans and easily converted to their machine form by an assembler. It is, in fact, child's play to translate a program from one to the other because of the one to one.

Machine language programs *are* transportable; all Z80 or other microprocessors obey the same set of machine instructions. The transportability problem arises only when the program is incomplete and relies on subroutines from the host computer, subroutines that might be at a different address in another computer or even missing from it. Of course there is the BIOS problem; trivial really.

Your statement that some computers don't have an accumulator floors me. Is your hardware knowledge so limited that you think any digital computer could operate without at least one accumulator? ENIAC had a dozen or more accumulators (20 if memory serves me) and although the von Neumann scheme cut back to one, that one has remained essential to digital computing. It was called the Mill by Babbage because that is where the work was done. The rest is just moving bits from keyboard to accumulator and to screen or from accumulator to screen, printer, storage, or modem. Perhaps, though, you have been misled by the term CPU, which has the accumulator as a vital part. Ask your friend Mr. Leventhal about it.

David Block
POB 12473
Gainesville, FL 32604

Assembly language is a hefty step up from machine language for me! I wish we'd had a good assembler for the IBM 360 I started with. . . .

I think you've foundered over a definition. While it's true that all computers (at least all I've ever worked with) have something that functions like an accumulator, some have a particular register dedicated only to that task, and some don't; which was all I meant by my remark that some "don't have an accumulator." . . . **Jerry**

Unix Notes from All Over

Dear Jerry,

In BYTE's User to User (September, page 480) James E. Densmore Jr. laments the lack of an ability to suspend execution of one program while running another under the Unix operating system. He is quite in error.

Any single-tasking system can accomplish this by saving an image of the register, memory space, and associated files. On a multitasking system such as Unix, the implementation is trivial: one merely suspends operation of one process upon a prearranged signal and continues with a second process which may or may not be running already. With newer versions of Unix supporting the Berkeley C-shell, one need merely type a control character to interrupt any process in the foreground. At the user's wish, the process may be killed, restarted, or relegated to a lower priority (background processing). Meanwhile, one can proceed with additional process(es).

Furthermore, the command interpretation procedure and recursive features mentioned by this reader have existed on Unix from its very early days.

Donn S. Fishbein, MD
4000 Tunlaw Rd. NW 820
Washington, DC 20007

My late mad friend was interested in Unix, but so far I don't have any machines that run it. I expect that will soon change. Meanwhile, I can collect stories. Thanks. . . . **Jerry**

Dear Jerry,

I would like to clear up a misconception on the part of James Densmore about Unix. He states that while MULTICS allows virtually infinite recursion in calling "command procedures," Unix does not. Well, UNIX *does* implement the concept of "forking," which allows other processes to be generated concurrently with the generating process. These processes can be any executable file, usually a compiled C program.

While infinite recursion is not feasible (a small limit, on the order of 8, is placed on the number of subprocesses running at once), it is very rarely used. Indeed, since C is completely recursive, most recursive tasks can be done within the command module (arguably where recursion belongs). As a final note, shell scripts (i.e., command files) are recursive. Since these have flow-control instructions available, they function much like procedures.

Finally, a question on Concurrent CP/M-86. If it can run more than one program at once, how does it prevent one from corrupting the other? The IBM PC, an 8086-like system, does not implement memory protection. Nor is memory mapping/vectoring facilitated; so how are programs relinked to function in different sections of memory? Finally, how does CP/M-86 compare with Unix's piping and redirection capabilities?

These are important questions since they directly affect the usability of an operating system like CP/M-86. While I can guess at methods by which a multiple-process operating system can function on a machine like the IBM PC (extensive swapping, instruction interpretation), none are acceptable. So, how does Concurrent CP/M work? As a systems programmer, I sure would like to know.

Michael Kilian
1869 Highland Ave.
Troy, NY 12180

I'll let others fight about Unix. Regarding Concurrent CP/M-86, I'm trying to do a good bit of a column about it. Alas, it's complicated by IBM: after three months they still haven't delivered the PC I paid for (by certified check, yet)! Until I've got that, I can't do much with Concurrent. Surely by the time you read this I'll have it. . . . **Jerry**

Dear Jerry,

In BYTE's User to User (September, page 480), James E. Densmore Jr. notes that MULTICS allows the user to interrupt a program being executed and return to it later, while Unix does not. This is not quite true, as the version of Unix for the VAX (distributed as version 4.1 Unix in the Berkeley "bsd" release) contains such a feature.

The implementation is nothing like the one used by MULTICS, of course. Instead, it takes advantage of the fact that Unix, like any multiprocessing system, has a way to checkpoint a process while other processes run. It simply defines a keyboard interrupt that forces the currently running process into that checkpointed state and returns control to the user's command-line interpreter (shell), using the existing signal facility. Provide a way to restart the stopped process from the shell, and you're done.

Considering that many prospective Unix system developers (and customers) are familiar with Berkeley Unix, that the feature is obviously desirable, and that it is not really very difficult to add the necessary process states and system calls to a "vanilla" Unix system during development, I should be surprised if this feature did not become standard in Unix systems, and if not tomorrow then soon.

Richard Hussong
Applied Reasoning Corporation
77 Trowbridge St.
Cambridge, MA 02138

They tell me that "vanilla" Unix is unusable by novices; and though Unix is easy to customize, once you've done that, there's no standard way things are done, and you're sort of on your own remembering your customizations.

Perhaps what it needs is some "standard customization?" . . . **Jerry**■

Praise for the Final Word

Dear Jerry,

In "Eagles, Text Editors, New Compilers, and Much More" (September, page 307), you made an apparently uninformed comment about a program I truly love: the Final Word word processor from Mark of the Unicorn. Not only will the Final Word format end notes automatically, it will do footnotes or in-line notes. It will automatically create and format tables of contents and indices too! It can make all kinds of lists, like file inclusion (Wordstar needs the Mailmerge option) and keyboard input during formatting. In this instance, the formatter will prompt you if needed, and you just type in the stuff you want included. It will format style changes at any point so that you can change things like margins, indentation, justification, paper size, note style, line spacing, and tab spacing any place in the file.

And besides the terrific formatter, the editor itself is nicer. It displays text faster. You can have up to 12 editing buffers available at once. Parts of two of those buffers can be displayed at once (this is incredibly handy). A feature called State Save saves changes after you stop typing for a few seconds. If power goes down while you are editing, the only material lost is that which had not been written out with the State Save. This has saved me a couple times as my town has an incredibly wimpy power system. You can leave the Final Word to do something else, then start again, and it will return to exactly where you left off. You don't need to read in the same file again. And commands really are mnemonic.

But, if you don't like something, the Final Word is almost infinitely configurable. You can change the keys that cause movement, for example. You can even change the width it uses to print individual characters if you want. The Final Word can do true proportional spacing on printers capable of supporting it, not just microjustification like Wordstar.

Wanna hear more? The documentation is really good in my opinion. There are nine lessons included. Three of the lessons consist of a disk file containing the output of the text used to create the same chapter in the printed documentation. The manual was created with the Final Word and, as such, contains a good table of contents and index.

The Final Word can do anything Wordstar does except suggest hyphenation. It costs less and has capabilities that you have to spend hundreds of dollars more for with Wordstar. I haven't covered half of them.

Also, support from Mark of the Unicorn is very good.

David D. Clark
246 South Fraser St. #2
State College, PA 16801

Yours is not the only enthusiastic letter I've received regarding the Final Word, and I know for a fact that Mark of the Unicorn provides good support to its customers.

I'm fairly set in my preferences for computer editors—given the tens of thousands of words I have to pour out each month, it would be surprising if I weren't—so it's unlikely that I'll make many changes. However, shortly after I began writing with computers, I discovered Electric Pencil. The program I use now, Write, grew out of the Pencil's strengths and defects.

Not long after I got used to Pencil I became involved with net traffic and, working with machines at MIT, I ran into EMACS. If it had been the first full-screen editor I'd worked with, I might well have become an EMACS enthusiast.

The Final Word, like Mark of the Unicorn's MINCE (Mince Is Not Complete EMACS), is based on EMACS.

"There are nine and sixty ways of constructing tribal lays, and every single one of them is right." Editors aren't quite so much a matter of taste as that, but certainly there's no single "best" one. Glad you've found one you like! . . . **Jerry**

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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Ask BYTE

Conducted by Steve Ciarcia

Getting Started

Dear Steve,

I am a beginner in the computer field. I hope to either buy a computer that teaches the design principles of computers or to design a computer of my own. Because I live in the United Kingdom, I have found it very difficult to find one. I was wondering if you might be able to help me. Are there any computers for sale in the U.S. that are good for beginners and are not too expensive?

I have seen two computers: the Ferguson Big Board and the Insight Enterprises computer. Would either of these be a good introduction to computer design and expandable enough later on? The Big Board doesn't seem to be. I have not been able to read any reports on these computers, though, and thus am skeptical about buying them. I would appreciate your comments very much.

Edward Newman
Sherborne, Dorset
United Kingdom

This is an excellent time for a beginner to enter the computer field as there are many low-cost, high-performance models from which to choose. One of the fastest sellers in this country is the Commodore 64. It features 64K bytes of memory, high-resolution graphics, a full keyboard, and a price as low as $200. A reference manual is available that describes the inner workings and advanced programming techniques.

The Radio Shack Color Computer is another low-cost model with the powerful 6809 microprocessor chip. It is well supported as evidenced by at least four magazines devoted exclusively to the "CoCo."

The two models mentioned are only representative of the vast number that are available. These models allow you to take the unit out of the box, add a TV or monitor, and start computing. If you want to configure your own system from one of the single-board units you mentioned, recognize that considerable additional equipment is required. Most require a terminal, power supply, and disk drives to function at all.

If you are a beginner, I would recommend buying one of the just-mentioned ready-made computers. As your knowledge increases, you will recognize the features that are important to you and those that are unnecessary. . . . **Steve**

Videodisc Interaction

Dear Steve,

I enjoyed your June 1982 article, "Build an Interactive-Videodisc Controller" (page 60). I, too, am very enthusiastic about the future potential of this technology.

Due to my lack of knowledge about electronic hardware and limited funds, I was unsuccessful in creating the coding necessary to control the Pioneer VP-1000. I thought that if I were successful, the software could be applied universally and interactive programming would not be dependent on the type of hardware interface a person owned.

I think the problem is that the Vic-20 I own is not capable of creating a 38-kHz tone. The Vic-20 has a 6502 microprocessor and a 6522 versatile interface adapter. It has a 1-MHz clock rate that allows 1 microsecond (μs) per cycle. Therefore, I can get only 13 μs instead of the necessary 13.15, creating a 38.4-kHz tone. Evidently, the carrier frequency must be exact for the VP-1000 to recognize the command.

I have a question about your article: in figure 2a, and in the text on page 65, it is indicated that the pulse burst is 0.263 milliseconds (ms) long and is included in the bit period. However, in figure 6 you indicate that the pulse burst occurs, and afterward there is a delay of 1.05 or 2.1 ms, depending on the logic code. It appears to me that for a logic=0 the first delay should be 1.05 ms minus 0.263 ms, or 0.787 ms. I have tested these and many other possible delay times, so I conclude that the problem is with the 38.4-kHz carrier frequency. Also, in a January 1982 article in Microcomputing *(page 103, figure 3), it is indicated that the pulse burst is 0.233 ms long and delay times are 0.93 and 1.86 ms. Was this a mistake, or has Pioneer changed things in newer models?*

Assuming that it is impossible for me to create the necessary coding due to the limitation of the 1-MHz clock rate, I am forced to resort to a hardware interface. Do you think that the 38-kHz crystal (Pioneer part number VSS-002) can be purchased and used as an external clock to control the necessary 38-kHz carrier frequency? Any ideas on how this might be accomplished would be appreciated.

Thank you for your consideration and any help you may be able to offer to help me create a low-cost universal VP-1000 controller.

Gary W. Schroeder
San Francisco, CA

The logic as stated in my article is correct. The bit period is defined as the time between the pulses; the length of the pulse itself is not significant for the coding. The carrier frequency is used for detection.

The article in the January 1982 Microcomputing *used the code values as supplied by Pioneer, which were incorrect. I discovered this when I designed my circuit, and I brought it to Pioneer's attention.*

Generating the necessary coding in software is extremely difficult. It is even more difficult to write a universal program since it is so dependent on machine timing. It is much easier to use some form of hardware assistance. The simplest is the 555 oscillator to generate the 38-kHz pulses and gate them under software control. If your hardware knowledge is limited, go with the circuit on page 72 of my article. It needs only 5 volts and is extremely easy to build. . . . **Steve**

Adding CP/M and Apples

Dear Steve,

I have an Apple II Plus with 48K bytes, two disk drives, and a 16K-byte RAM card. I would like to use it for CP/M. What additional hardware do I need? What is the difference between a Z80 card and Microsoft's Softcard? Do I need both? Thank you.

Jim Fox
Peckville, PA

To run CP/M on your Apple II Plus, you need a card that contains a Z80 processor chip. Many such cards are on the market at various prices. The cheaper ones do not come with the CP/M operating system. The softcard is Microsoft's version of a Z80 card and includes the CP/M operating system with several utilities and Microsoft BASIC.

Many of the programs that run under CP/M require an 80-column screen and uppercase/lowercase capability. An 80-column card should also be purchased to fully utilize the system.

Make sure that your CP/M card is compatible with your 16K-byte RAM card and your 80-column card. Most cards are fully compatible, but some are not. Be sure to ask. . . . **Steve**

Interpreting Information

Dear Steve,

Can you recommend a source of information on the details of BASIC interpreter operation? It doesn't matter to me which microprocessor is used. I'm just looking for the fundamentals. Thank you.

Jorge S. Lucas
Belo Horizonte, Brazil

In the early days of microcomputers, at least one publication featured a series of articles on the workings of BASIC interpreters. There were listings of some Tiny BASIC interpreters for an 8080-based system, and general operation was discussed. They are contained in volume 1 of Dr. Dobb's Journal of Computer Calisthenics & Orthodontia *(*Dr. Dobb's, *for short) and can be obtained from Hayden Book Company Inc., 50 Essex St., Rochelle Park, NJ 07662....* **Steve**

BASIC Precision

Dear Steve,

I have a suggestion and a question: how about an article on building a switching-regulator power supply using power MOSFET for the S-100 bus? I'm enclosing a copy of an article from Electronic Design *(February 17, 1983, page 135). This would cut down on the heat dissipated both on the boards and in the enclosure and also conserve on energy.*

I am doing a lot of work with the NBS (National Bureau of Standards) Temperature Tables. This work involves the use of polynomials and requires 54-bit accuracy to duplicate the results from the tables. My Polymorphic Systems 8813 BASIC has the ability to use up to 26-digit precision, which appears to be good enough for the job. The computer I use at work is an Altos 8500 running under CP/M and Microsoft BASIC. The Microsoft BASIC does not have the required precision.

My question is this: can someone suggest a method for evaluating the precision of various BASICs, or does someone know of a CP/M BASIC that will have the desired precision?

Joseph R. Toman
Skokie, IL

Thank you very much for your suggestion. I have addressed this subject on a smaller scale in the November 1981 BYTE (page 36) but will keep your idea open for a future article.

Regarding the question of precision of various BASICs, it seems to me that you are mixing "bits" and "digits." For example, Microsoft BASIC has a real data precision of 7+ significant digits and is represented in the computer in a 4-byte, floating-point form. Of these 4 bytes, 1 represents the characteristic and 3 represent the mantissa. Thus, there are 3 bytes, or 24 bits, of precision allocated to the mantissa.

If double precision is used, 16 digits of precision are obtained, and the representation is 8 bytes, 1 of which is allocated to the characteristic. The remaining 7 bytes (56 bits) apply to the mantissa.

Hence, 16 digits of precision corresponds to 56 bits of accuracy. This seems more than adequate for the NBS tables to which you referred. To evaluate other BASICs, the storage format and the byte representation of the numbers must be known. ... **Steve**

Author! Author!

Dear Steve,

I would like to start writing articles for computer magazines. I have a bachelor's degree in computer science and math, along with eight years of experience in the computer field. I love microcomputers. I would appreciate any help you could give me. Thanks.

Joseph M. Ruvolu
Staten Island, NY

Writing articles for computer magazines, or any magazine for that matter, requires a subject that is appealing to a large audience and a certain style of presenting that subject. There are many computer magazines catering to different levels, and you should concentrate on those where your expertise can be utilized. You will have little chance of publishing a highly technical article in a magazine such as Popular Computing, *since it is not aimed at that audience.*

One way is to write an article or two and submit them to potential publishers. You can judge from their responses whether you are on the right track.

Take a look at "A Step-by-Step Guideline Outlines Writing for Publication" by George R. Dunn in the October 20, 1980, issue of EDN magazine. It offers some good advice for potential writers. ... **Steve**

Apple Emulator

Dear Steve,

I have been told that some place in the market is a device that can be used with a Commodore 64 that enables it to utilize all the available Apple software. I think it is called an "emulator." I have called a number of computer distributors without success, and I thought that you might have come across this device. If so, I would appreciate your directing me to the appropriate source so that I might get further information.

Many thanks for your help.

Morton J. Perlin
Miami, FL

The device that will allow the Commodore 64 to read Apple II software is called the Amulator and is manufactured by Advanced Integrated Development. The unit sells for $129 and requires you to physically remove the 6510 microprocessor chip in the Commodore 64 to piggyback the Amulator. Once installed, the unit will read most 40-column Apple II software but will not allow writing to a disk.

There have been many rumors of Apple emulators and personality modules for the Commodore 64. In fact, the introductory articles describing the 64 touted, as one of its features, the ability to emulate other popular computers. It seems that this has finally come to pass.

Further information can be obtained by contacting Advanced Integrated Development, 5901 John Martin Dr., Brooklyn Center, MN 55430, (612) 561-1645. ... **Steve**

Entrepreneurship

Dear Steve,

I have developed a plug-in board that gives (I believe) the Apple II computer sound capabilities as good as the Commodore 64. I would like to manufacture and market it, but I don't have the resources to do so. For that reason, I would like to have a company manufacture it for me. Can you tell me who might be interested in manufacturing it for me or how to go about finding someone who would?

Mark E. Rogers
La Place, LA

Yours is a problem shared by many budding entrepreneurs. You will find that engineering a prototype board represents only about 10 percent of the time and money involved to bring the final product to market. With advertising in magazines as high as $8000 per page per month, it is no wonder that few have the resources to complete such projects.

Having another company manufacture your board is a logical approach, but don't expect to get rich. Stop and think *what the board could reasonably sell for and then determine the wholesale cost to the dealer (40 to 50 percent of list price). Then estimate the cost and profit of the manufacturing house, add in advertising and promotions, and the remainder may be yours. Approach some of the houses currently making cards for the Apple II to determine their interest. Then see if any of the offers are satisfactory....* **Steve**

Photon Control

Dear Steve,

I'm interested in controlling lights with a computer. I want to memorize and play back patterns of between 5 and 20 lights activated at different times for different durations. What type of interface device do I need? I'd prefer to use an inexpensive Vic-20 if possible. Thanks for your help.

Randy Maule
Gainesville, FL

The Vic-20 has a 6522 versatile interface adapter chip that contains eight I/O (input/output) lines. Additional I/O lines can be added through the use of an expansion bus. Each line can be programmed as an input or output and read simply by examining (using the PEEK command) the memory location for which the chip is mapped. Assign one line to each light to be detected and use a phototransistor to convert the light input to a 5-volt DC output. It might be helpful to have one line available to sense the presence of any *light.*

Your program could then poll the "any light" line to see when a light has been turned on. Then, depending on the duration of the lights to be "memorized," the program could read these lines at equal intervals and store the data. This would continue until the "any light" line sensed the absence of light.

To simply turn lights on and off, use an optoisolator and a relay. The optoisolator consists of an LED (light-emitting diode) and a phototransistor. When your computer I/O line sends a logic "1" (5 volts DC), the LED glows and causes the phototransistor to conduct, closing a relay. ... **Steve**

Video for the Sym-1

Dear Steve,

It is very difficult for me to get literature and components for experimentation, and I hope you can spare me a lot of aggravation and wasted time.

I bought a Sym-1 microcomputer and built a power supply and ASCII keyboard, but I don't know how to obtain a video output from my TV, which I've adapted for direct video display. The Sym's block diagram shows that some kind of "TV/keyboard interface" is needed. Can you help me? Thank you very much.

Tomo Mlinaric
Zagreb, Yugoslavia

A device known as a video-display board or "TV typewriter" is required to obtain video output for your Sym-1 computer. Such a device takes an ASCII input from a keyboard or computer output and converts it into video characters that can be displayed on a TV monitor screen. A construction article appeared in the February issue of Microcomputing *(formerly* Kilobaud*) magazine on page 70. "Build a $50 TVT!" by Duane Amundson describes a device capable of displaying 16 lines of 32 characters, using readily obtainable parts. Its low cost makes it an interesting project....* **Steve**

P.S. *See my article this month for a terminal you can build.*

Vic Expansion

Dear Steve,

Is it possible to build an expansion bus for the Vic-20 similar to that used with the Apple II? They both use the 6502 microprocessor. If this can be done, can you tell me where I can obtain the necessary technical information? Would function boards designed for the Apple then be compatible with the Vic-20? Thank you for your help.

Larry W. Snead
Danville, VA

While the Vic-20 and the Apple II both utilize the 6502 microprocessor chip and both can have expansion buses, peripheral cards designed for the Apple will not work on the Vic. Aside from different timing considerations on the bus, the Apple cards have on-board ROM (read-only memory) that contains programs to control their functions. These programs call routines that are either not available or are located in different memory areas in the Vic.

An expansion bus can be made or purchased for the Vic. See the back pages of any computer magazine containing Vic-20 articles for advertisements. I recently saw an ad for a 4-slot expansion bare board for only $19, including instructions. You may want to go this route, as it will save you a lot of wiring. Contact The Data Toolbox, POB 4808 V, Las Vegas, NV 89127, (702) 648-3258.... **Steve**

Assembling a Z80

Dear Steve,

I am a senior at Monroe High School and vice-president of the Monroe High School Computer Group, an offshoot from our computer-science class. After doing some heavy 6502 machine-language work, we just touched on the Z80. Recently, I purchased a Timex/Sinclair 1000 and am looking for a good assembler. I've read several books but haven't been able to find any handy subroutines for the Z80 similar to those we used with the 6502. Can you make some recommendations for a Z80 assembler and subroutines? Thanks for your help—I enjoy your column.

Jeff Kopmanis
Monroe, MI

Gladstone Electronics carries a complete line of accessories for the Timex/Sinclair 1000 computer. Included are several books on the internal workings of the Sinclair (ZX-81) ROM. Two such books are Understanding Your ZX-81 ROM *by Dr. Logan and* The Explorers Guide to the ZX-81 *by Mike Lord. Several utility programs, including an assembler, machine-code monitor, and disassembler, are also available. For further information, write or call Gladstone Electronics, 1585 Kenmore Ave., Buffalo, NY 14217, (800) 833-8400. Ask for a catalog and get on the company's mailing list.* ... **Steve**

Bulletin Boards

Dear Steve,

I have an Apple II Plus and a Micromodem at home, and I'd like to use them to get games from some of the bulletin boards. Can you direct me to a list of available bulletin boards and tell me how to communicate with them? Thank you.

Matt Wainwright
Brookfield, CT

Computer Shopper, *a computer-oriented classified-ad newspaper, publishes a monthly listing of bulletin boards around the country. There are several in your state and many in surrounding states, so finding one to your liking should be easy. To access a bulletin board, it is only necessary to dial the telephone number and connect your modem when you hear the carrier signal. Some modems connect automatically. Usually, the Return key is hit once or twice, after which the system will ask you some questions about your equipment. This is necessary so that it can adapt to your particular equipment format. A* *menu is then presented, and you can select your choice.*

Some form of communications program is required so that your system can simulate a terminal. Some modems come with the required software. That is all that is required to enter the world of bulletin boards.... **Steve**

Kaypro Word Processing

Dear Steve,

I want to be able to edit documents that are about 200 single-spaced, typed pages (600K bytes) long on a Kaypro II or Kaypro 4. I'd guess that others who use similarly modest microcomputers for word processing might want to be able to edit documents that exceed both their machines' available RAM and the capacity of one floppy disk. Is there any economical and practical way of getting around the RAM and disk-memory limitations of many machines without recourse to the comparatively expensive solid-state disks or hard disks?

Perfect Writer, with its virtual-memory feature, would seem to offer one way around RAM limitations, but this doesn't solve the problems (e.g., in pagination and, therefore, in index creation) posed by a document too large to fit on one floppy disk. In addition, as configured for the Kaypro, Perfect Writer has a limited swap-file size (not useful for editing more than 20 pages), and the program for reconfiguring is not supplied in the Kaypro software package.

I'd appreciate your help in finding answers to the questions I've raised. I know of at least seven Kaypro owners who are also seeking answers to them.

David F. Austin
Amherst, MA

Practically speaking, there is no way short of a hard disk or RAM disk to handle 200 pages of text on your Kaypro. The computer must be able to read the complete data file in order to operate on it, and this necessitates that it be on line as far as the program is concerned. Breaking the file into several smaller files is the recommended approach.... **Steve**

Video Displays

Dear Steve,

For some time now, I have been trying to acquire information on the possibility of providing an 80-column by 25-line black-and-white video display for a TI-99/4A computer used for word processing. This would avoid the horizontal scrolling now necessary.

Is it feasible to acquire an independent peripheral (monitor) that will provide this display? Would it operate through the RS-232C serial or parallel ports? Would such a unit be a combination of a stand-alone video board and a standard wide-band monitor? Could you suggest an available unit of modest cost? (Some of the suggestions have been for units that by themselves exceeded the total cost of our installation.)

Could you alternatively suggest a setup that, with our modest skills, we could put together? Would the CRT terminal outlined in chapter 9 of your book (Build Your Own Z-80 Computer) *do the job? Thank you for your assistance.*

Norman J. Spector
Englewood, FL

Obtaining an 80-column display on your TI-99/4A is not simply a matter of adding a wide-band monitor or terminal. The video-generation circuits in the computer itself must be modified along with the software. I have seen accessory boards for computers such as the Vic-20 that allow 80 columns, but they cost more than twice the price of the Vic. I am not aware of such a unit for your TI, but I would suspect that the cost will be rather high also. The electronics on such a card are quite sophisticated and are not recommended as beginner projects.

The horizontal scrolling that you have with your word-processor program is a simple means to overcome a shortcoming of the computer. Remember that the character width was purposely reduced to allow the use of an ordinary television. If you add an 80-column card, you will also need a high-resolution monitor to display the additional characters.... **Steve**

Andromeda and CP/M

Dear Steve,

About two years ago, I purchased an Andromeda 16K-byte card for my Apple II, and it has been working fine with Applesoft and DOS ever since.

About a month ago I bought an Advanced Logic Systems (ALS) Z-Card with CP/M 2.2. The CP/M from ALS comes configured for 48K bytes of memory, and ALS supplies a utility program to reconfigure for 64K bytes. But no matter what I tried, my reconfigured CP/M would not operate.

I wrote letters to ALS and Andromeda asking them what was wrong. Andromeda replied that its card won't work with CP/M version 2.2. The company had heard of some people "patching" their boards to make it work but didn't know what changes were made. Andromeda suggested contacting a club or users group. I contacted A.P.P.L.E. but haven't had any luck yet.

Do you know how I can modify my Andromeda card to work with the CP/M 2.2?

Steve Nelson
Arlington, TX

An article in the August 1983 CALL A.P.P.L.E. *may solve your problem. "Andromeda Ramcard Patch" by Jay H. Lieske describes the changes to CP/M BIOS (basic input/output system) required to utilize the Andromeda 16K-byte card with a 60K-byte version of CP/M. It may work with your combination of CP/M and RAM cards. In any event, you can see what is necessary to activate the card....* **Steve**

TI-99/4A Compatibility

Dear Steve,

I own a Texas Instruments TI-99/4A computer and want to know if there are any circuits that will make it compatible with a Bell-103-type modem and/or a Heath/Zenith Z80 microcomputer. Thanks for the help.

Jacob E. Dockter
Bismarck, ND

Compatibility between your TI-99/4A and peripherals and modems is easily achieved through the use of the RS-232C serial port. This port is obtained with the Peripheral Expansion Interface. The ECM-103 ("Build the ECM-103, an Originate/Answer Modem," BYTE, March 1983, page 26) modem can be directly connected to this port and, since it is Bell-103-compatible, used to link up to The Source or other bulletin boards.

The Heath/Zenith microcomputer has a serial port for use with a terminal.... **Steve** ■

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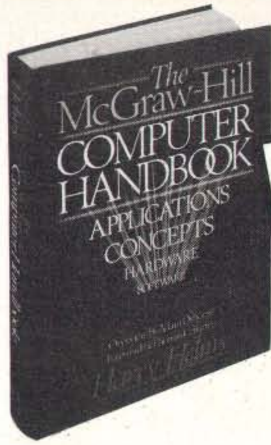

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Software Received

Apple

Braille-Edit, a word-processing program for blind and sighted persons to perform text-editing operations using voice, screen, or a braille computer terminal. It is designed to work with many braille and voice devices, enabling the user to write, edit, correct, and print out formatted letters, reports, and papers using braille- or print-oriented text files. Includes audio and Versabraille tapes. For II Plus or IIe; floppy disk, $300. Raised Dot Computing, 310 South 7th St., Lewisburg, PA 17837.

Computer Calculator, a calculator program. Turn your computer into an algebraic and Reverse Polish Notation (RPN) calculator. Features include automatic conversions and balancing, calculations in decimal, hexadecimal, and binary, and user-defined functions. For the II Plus; floppy disk, $19.95. Jim's Software, 384 The Great Road, Bedford, MA 01730.

Cubit, a three-dimensional strategy game in which you must change the color of cubes by jumping on them. Beware of bouncing balls, disguised snakes, and vicious gremlins who get in your way. For the II; floppy disk, $39.95. Micromax Systems Inc., 6868 Nancy Ridge Dr., San Diego, CA 92121.

Fastform, a business program that lets you create business forms, fill out standardized forms, and perform numerical calculations. You can save all data on disk. For II Plus and IIe; floppy disk, $34.95. User-Friendly Software, 3204 National Parks Highway, Carlsbad, NM 88220.

Finance & Amortization, a business program for banking and financial companies to calculate amortization schedules for loans, leases, and savings accounts. Features include investment-decision and loan-analysis capabilities. For II Plus and IIe; floppy disk, $29.95. User-Friendly Software (see address above).

Fortress of the Witch King, a fantasy game. Your quest is to slay the ruler of the fortress and gain power through the orb, scepter, and crown. Your band of warriors is constantly in danger of the Witch King's warriors or the vicious hacker who want what you have gained. For II, II Plus, and IIe; floppy disk, $25. Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

The Graphics Magician, a programmer's tool that assists in the layout and design of homemade arcade games and high-resolution graphics programs. These new versions of the graphics editor and machine-language routines let you design shapes and their paths and assemble and control animations with your own programs. For the updated version, send your old disk and $15 to Penguin Software. For the II; floppy disk, $59.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

Introduction to BASIC Programming, a training and utility package. This four-disk series teaches computer literacy while training the student in BASIC programming. A quiz module in each lesson is scored automatically and evaluated by the computer. For II Plus and IIe; floppy disks, $149.95. Orion Training Systems, POB 94, Dallastown, PA 17313.

Job Cost III, a business program that lets you keep track of 350 items of cost and quantity totals. Headings can be entered for 35 categories and 10 subcategories for cost-to-date figures. Additional categories keep track of subcontracts, overhead figures, cash advances, loans, or final payments without figuring in the cost-to-date figures. For the II Plus; floppy disk, $34.95. User-Friendly Software (see address above).

Magicalc, an electronic spreadsheet program. You can create, manipulate, modify, and print reports that include such calculations as financial statements, budgets, cost estimates, sales forecasts, staffing plans, and development and product schedules. For II and IIe; floppy disk, $149.95. Artsci, 5547 Satsuma Ave., North Hollywood, CA 91601.

Matrix Utility, a matrix-manipulation program that computes eigenvalues, inverses, determinants, characteristic polynomials, and ranks of a matrix. It also solves linear and polynomial equations. Programming experience is not necessary to operate program. For the II; floppy disk, $34.95. Wesware, 2349 Fir, Glenview, IL 60025.

Miko tekst, a word-processing package. You can edit letters or memos; chart your own chapters, index, or table of contents; and print, format, or delete files. Documentation accompanies four disks: text, help, letter, and DOC. For II and IIe; floppy disks, $190. Tomi Data, Kirkerudkleiva 4, 1313 Voyenenga, Norway.

Minit Man, a trilevel arcade-type game. Waves of robots have already destroyed the bridge, and your missiles are on the other side. Your job is to rebuild the bridge while simultaneously defending your building complex that houses the computer. Requires a joystick. For the II; floppy disk, $19.95. Penguin Software (see address above).

Monthly Accounting, an accounts-management program that handles up to 100 expense and income accounts for business and home purposes. Monthly transactions can add up to six-digit quantities ranging from mortgage payments to gas mileage. For II Plus and IIe; floppy disk, $19.99. Softcell, 13 Webster Ave., Hanover, NH 03755.

Net-Works II, an electronic bulletin-board program for home or business uses. This program automatically answers and records phone calls. It enables users to send messages to individuals, distribute memos, and use as a 24-hour-a-day message center. For the II; floppy disk, $99. High Technology Software Products Inc., POB 60406, 1611 Northwest 23rd, Oklahoma City, OK 73146.

PTD—6502/6510 Debugger, an assembly-language utility. This program enables the user to write, modify, and debug games and utilities using BASIC editing features. Includes an 80-page tutorial manual. For the IIe; floppy disk, $50. Pterodactyl Software, 200 Bolinas Rd. #27, Fairfax, CA 94930.

The Scrambler, a disk protection/password system. This program lets you check disks for errors, copy-protect your disks by using a password system, and create a scrambled data disk that can be stored. It will verify disks in 12 seconds. For II Plus and IIe; floppy disk, $28.95. Jagware, 127 Albany Ave. SE, Orange City, IA 51041.

The Spy Strikes Back, a high-resolution graphics game in which you must locate Dr. X's terrorist operation. Reports reveal that each of the five floors in his hideaway is divided into 24 guarded sections, containing 16 rooms. The object is to get through these rooms without being seen or getting caught. For the II; floppy disk, $19.95. Penguin Software (see address above).

Stockfile, a stock-control program for smaller businesses. You can store up to 1000 stock lines on one disk. Using extra disks, up to 30,000 stock lines can be created, viewed, updated, corrected, or printed. It automatically calculates stock values. For II and IIe; floppy disk, $95. Felix Software, 19 Leighton Ave., Pinner HA5 3BW, England.

Super Disk Labeller, a machine-language utility package. Prepare and print floppy-disk labels that organize your disks into a library. This program allows use of a variety of printers using the printer configuration mode and lets you print labels of almost any size with the label-options mode. Requires Applesoft in ROM. For II, II Plus, and IIe; floppy disk, $34.95. Lakefront Software, 7754 Balboa Blvd., Van Nuys, CA 91406.

Talk-U-Thru Wordstar, a step-by-step tutorial program to teach the functions of Wordstar. This program features an introduction to CP/M, Wordstar installation, cursor moves, text moves, deleting and inserting text, onscreen formatting, file-management techniques, and a variety of other functions. Includes audiocassettes covering installation, cursor moves, and formatting and printing. For II, II Plus, IIe, and III; floppy disk, $49.95. Talk-U-Thru Tutorial Systems, 6519 Fountain Ave., Los Angeles, CA 90028.

Teacher's Pet, a report-card program that can keep track of an unlimited number of students ranging from elementary to high school. Up to 800 objectives can be placed on the master disk, which already contains about 700 standard objectives. For II Plus and IIe; floppy disk, $300. Softcell (see address above).

Atari

Computer Football Strategy, a football-simulation game similar to the board game. Pit your strategic skills against the computer or a live opponent as you call both offense and defense plays. Many formations to choose from as the game clock ticks away. For 400/800; cassette, $16. Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

The Arcade Machine, a game-creation program. Develop your own animated creatures, spaceships, aliens, tanks, monsters, or other objects to move over a variety of backgrounds. Include such sounds as explosions, musical tones, and other sound effects as you design your own arcade games. For 400/800 and the XL series; floppy disk, $59.95. Broderbund Software Inc., 17 Paul Dr., San Rafael, CA 94903.

B/Graph, a professional graphics-charting and statistical-analysis program. You can assemble, process, and display complex, extensive numerical data in graphic form with this comprehensive, two-disk package. For 400/800; floppy disk, $99. Inhome Software Inc., Unit 8, 2485 Dunwin Dr., Mississauga, Ontario L5L 1T1, Canada.

CP/M

Billchecker, a personal financial program that runs CP/M 2.2. This lets you handle check writing and bill paying. When you categorize bills due, their dates due are automatically updated. Checkbook will hold up to 200 transactions with six-digit numerals using double precision. Floppy disk, $39.95. Extal Alstar Inc., POB 850, Rome, NY 13440.

CP/M.D., a utility program that diagnoses and cures ailments of CP/M disks. Menu-driven functions and a variety of commands recover files from bad disks, locate and lock out bad sectors, and translate decimal numbers to hexadecimal and binary codes. Floppy disk, $29.95. Teleprint Inc., Simpl-Simon Software, POB 10, Sylvania, GA 30467.

Magic/L, a general-purpose interactive language. Applications include mailing-list, hardware diagnostics, debugging routines, an image-processing system, database query system, a turnkey process-control system, and a cross-assembler program. Floppy disk, $295. Loki Engineering Inc., 55 Wheeler St., Cambridge, MA 02138.

Menu, a utility package that automatically sorts disk files using number codes without typing filenames. You select numbers and Menu handles functions such as copy, rename, erase, type, restore, compare, and more. You can secure sensitive disk files with password protection and explore the internal system while programming. Floppy disk, $149. Computing, 2519 Greenwich St., San Francisco, CA 94123.

Real-Time C, a utility program that provides users of Whitesmiths' C compiler with an alternate run-time library suitable for real-time programming. The library consists of approximately 100 modules combined into two library files. Features include command-line parsing and error handling accessible to the application programmer. Floppy disk, $95. Kadak Products Ltd., 206-1847 West Broadway Ave., Vancouver, British Columbia V6J 1Y5, Canada.

SAL/80, a utility compiler and language program. This program lets you maintain and reduce development and debugging time, and test branch code. It includes a complete set of console input/output primitives that perform case and base conversion, byte, word and string input/output through standard system calls and provide data manipulation using arithmetic functions. Floppy disk, $59. Protools, 24225 Summerhill Ave., Los Altos, CA 94022.

Text Addresser, a word-processing package that runs CP/M 2.2. A categorized address book automatically addresses letters. You can edit, move text, center text, and print. Floppy disk, $39.95. Extal Alstar Inc. (see address above).

Commodore

Casual Writer, a word-processing program. You can write letters and lists, print club bulletins, and store information on tape. For the 64; cassette, $29. E.N. Publications, RD 1, Box V, Worden, IL 62097.

Design-a-Quilt, a graphic-design program that can design more than 450 million quilt patterns. You key in a value for colors, blocks, and patches per block for a symmetric arrangement of quilt patterns. For the VIC-20; cassette, $29.95. Don's Designs, 1728 Womer, Wichita, KS 67203.

The Home Budget Ledger, a home-accounting program. This electronic checkbook and budget planner lets you set up spending categories to format as general ledger pages. It shows check numbers and descriptions, debits, credits, and balances. It also features routines to track checks, noncheck transactions, and disk backup. For the 64; floppy disk, $24.95. Harpware—Software and Computers, POB 760954, Dallas, TX 75376-0954.

Intermediate Language and Math, a five-program educational package for ages 10 through 12. Program titles include Nouns and Verbs, Adjectives and Adverbs, Rocket Launch, Add Speed, and Math Squares. For the 64; cassette, $34.95 for all five programs or $9.95 each. Baned Software, 113 Tenth St., West Keansburg, NJ 07734.

PTD—6502/6510 Debugger, an assembly-language utility (see description under Apple). For the 64; floppy disk, $30. Pterodactyl Software, 200 Bolinas Rd. #27, Fairfax, CA 94930.

IBM Personal Computer

Codewriter, a utility program that lets businesspeople design their own programs without computer programming experience. Possible applications include payables and receivables, sales analyses, customer and personnel files, mailing lists, invoicing, and inventory tracking. Floppy disk, $399. Dynatech Microsoftware Inc., 7847 North Caldwell Ave., Niles, IL 60648.

Empire, a global-conflict simulation game. You must annihilate other armies on a large map to gain total domination of the world. Requires strategic concentration. Floppy disk, $40. Northwest Software, 15343 Southeast 43 Place, Bellevue, WA 98006.

Fast File, an applications-generator program designed for novice users to design their own application programs. This program can be used to create automated systems such as inventory, accounting, mass mailing, and other data-tracking systems. You can manipulate data, design reports, and generate labels. Includes security-protection features. Floppy disk, $695. ICCS, 7777 Leesburg Pike, Falls Church, VA 22043.

Fixed Asset Manager, a financial-scheduling tool. Two depreciation schedules and various assets can be cataloged for business and personal uses. Features include standard depreciation methods, assets classified by location or type, extensive inquiry, and exception reporting. Floppy disk, $150. Softrend, POB 1462, Charlottesville, VA 22902.

The Itemizer, a financial-record-keeping program. This program lets you define up to 90 categories which can be printed, saved in a file, or displayed on the screen in summary and detail form. Floppy disk, $39.95. People Literate Software, POB 2039, Bozeman, MT 59715.

Manager Program Collection, an integrated scheduling and financial-planning system that contains three programs. Task Manager provides daily schedule control and a job-expense accounting system. Records Manager offers a client- and associate-information filing system. Project Manager is a project-planning and resource-analysis system. Floppy disks, $499. Datamension Corp., 615 Academy Dr., Northbrook, IL 60062.

The Real Estate Consultant, an investment-analysis package. This package assists in comparing real estate investment yields against alternative investment potentials such as individual ownership vs. partners, rent-or-buy decisions, tax status vs. new tax shelters, and timing a sale vs. holding. Floppy disk, $275. Consultant Systems Inc., Suite #311, 3704 State St., Santa Barbara, CA 93105.

Samna Word II, a word-processing business package. You can write, edit, and review any document with flexibility. This program also supports multiple window operations, a fold feature for wide columnar documents, floating footnotes, and a zoom feature that lets you see page makeup. Floppy disks, $450. Samna Corp., Suite

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Graphics for the IBMpc, Apple, Z-100

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Super Chartman II, a business-graphics-presentation program. Up to six graphs and charts can be displayed on one page, and stored data can be transferred from one graphic format to one of 20 others. This program is menu- and input-form-driven; the manual is designed for the nontechnical user. Floppy disk, $425. Graphic Software Inc., 1972 Massachusetts Ave., Cambridge, MA 02140.

Time Value of Money, an investment problem-solving tool. Make financial decisions based on analyses of compound interest, mortgage, annuity, and gradient. Create investment and payment schedules, merge these with reports, and file for future reference. Floppy disk, $39.95. People Literate Software (see address above).

Type & Learn, a typing-instruction program. Learn how to type while you learn about computers by matching computer terms, definitions, and paragraphs of computer information. This program calculates your score, accuracy percentage, and words-per-minute speed. The progress of your typing skills is reported. Floppy disk, $60. Simsoft Inc., POB 7095, Port Huron, MI 48301.

Type-Righter, a typing-tutor program. Both novice and beginning users can develop speed and accuracy in typing. Color and graphics are used to highlight keys and reinforce the lessons. Floppy disk, $19. Martin Oakes, 2100 Oriole Dr., Freeport, IL 61032.

Universal Loan Planner, a loan-planning utility program. You can plan the terms of a loan and the printing of an amortization schedule. Features also include calculation of minimum payment, interest rates, amortization periods, and the maximum amount you can borrow. Floppy disk, $59.95. Andy's Software, Group 1, Box 44, RR 6, Bowmanville, Ontario L1C 3K7, Canada.

Util, a utility package to manipulate ASCII data files. Programmers can use these filter functions to provide flexibility in command lists processed by the batch-command processor. Floppy disk, $30. John R. Hind, 4100 Pickwick Dr., Raleigh, NC 27612.

WS-Patch, a utility package to enhance your printer's power using Wordstar. This program patches special information into programs to enable special printer functions. It amends the print-control menu to reflect letter-quality printing such as boldface, italics, superscripts, and subscripts. Floppy disk, $49.95. CMB3 Enterprises, POB 3061, Walnut Creek, CA 95498.

Osborne 1

Animate, a graphics and animation-processor program. Using ASCII and graphics characters you can create pictures on the screen to edit, save, print, combine, and display. Floppy disk, $30. Softborne Software, 1217 Hawthorne Lane, Fort Washington, PA 19034.

Cypho.bas, an interactive program that performs cryptographic algorithms on alphabetic text. The program encrypts or decrypts data entered from the console or in a disk file, and sends the resulting data to the disk file. Floppy disk, $10. Graven Imagery, Apt. 111, 50 Walmer Rd., Toronto, Ontario M5R 2X4, Canada.

Magic, an investment-analysis program. Enter the values for up to 15 investments based on daily, weekly, or monthly data, and Magic provides 6 moving averages and 12 ratios of moving averages for relative strength and momentum oscillators. You can compute averages for different time periods. Floppy disk, $49.95. $ware Tools for Investors, POB 645, San Luis Rey, CA 92068.

TRS-80

Autoplot, a graphics program that automatically plots curves in color. Choose from among line graphs, scatter plots, and bar graphs plotted from mathematical functions or tabulated data. Axes are automatically scaled and labeled. For the Model 100; cassette, $39.50. Menlo Systems, Suite 221, 3790 El Camino Real, Palo Alto, CA 94306.

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This is a book/disk package of programs in BASIC for the application of statistics to business, science and engineering. Emphasis is on understanding statistics and using micros for the quick solution of real-life problems.

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Dyfin, a personal financing program. Make financial decisions on loans, savings, investments, and retirements. This program can calculate monthly payments or returns and balance a checkbook. A 500-year calendar feature includes a monthly display. For the Color Computer; cassette, $19.95. Dynamic Electronics Inc., POB 896, Hartselle, AL 35640.

Maze Runner, a maze-type game. Create your own mazes or play the maze games already on disk. Test your skill and speed as the maze constantly changes. For the Models III and 4; floppy disk, $9.95. Point Video Products, Box 34, 2005 A St., Garden City, KS 67846.

Options 80A, a stock-option analyzing program. Investors can maximize stock-market yields, plot returns against actuals, and print graphs alphanumerically. This version includes Black-Scholes modeling and put-option spreads. For Models I and III; floppy disk, $170. Options-80, POB 471, Concord, MA 01742.

Paintpot, an extended BASIC educational program for all ages. Four-color graphics can be sketched using arrow keys, a joystick, or mouse; colors are selected from an on-screen palette. Four screens can be stored at once. For the Color Computer; cassette and disk, $20 and $25, respectively. Tim Skene, 6073 Durocher Ave., Montreal, Quebec H2V 3Y1, Canada.

Scribe, a word-processing program. In addition to editing text files, you can print letters and reports in finished forms using a dot-matrix printer. For the Model 100; cassette, $24.95. Chattanooga Systems Associates, POB 22261, Chattanooga, TN 27421.

Texas Instruments 99/4A

Dow Editor/Assembler, a utility package that provides the ability to program in assembly language, save on cassette, restore the program from cassette, and display the program on the monitor. Cassette, $25. John T. Dow, 6360 Caton, Pittsburgh, PA 15217.

Wild Woods, an arcade-type game. After you are dropped from an airplane, you must fire your flamethrower to reach land safely and to forge through a dense forest in search of treasures. Avoid the rushing river, incoming tide, and the search plane. Cassette, $11.95. JW Software, 814 West Main St., Urbana, IL 61801.

Wycove Forth, a programming-language program. Gain high-speed programming and control of the computer using printer access, sound, sprites, a graphics mode, text mode, and bit-map graphics-mode displays. Floppy disk with cassette, $50. Wycove Systems Ltd., POB 1105, Dartmouth, Nova Scotia B2Y 4B8, Canada.

T/S1000 and ZX81

The Fantastic Music Machine and Light Show, a two-part program. Music Composer transforms the keyboard into a three-octave musical instrument that plays through a radio. Light Show animates random kaleidoscopic patterns or lets you create your own designs. Cassette, $9.95. Simulusion, Box 894, Lemon Grove, CA 92045.

Party Nibbles and Bites, a fast-recipe program. A dozen party recipes instantly appear when you select from the menu of choices. Cassette, $9.95. Simulusion (see address above).■

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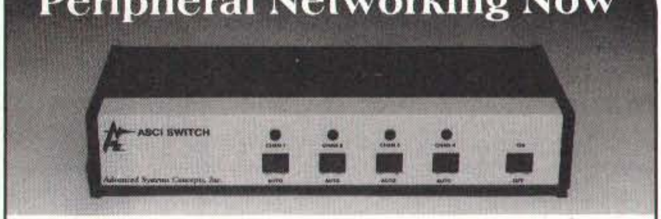

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This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Event Queue

January 1984

January

Courses from Q. E. D. Information Sciences, various sites throughout the U.S. Scheduled courses include "Cost-Benefit Analysis," "Leadership: Managing and Influencing People," and "Designing Systems Controls." Address inquiries to Q. E. D. Information Sciences Inc., Q. E. D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

January-February

Fundamentals of Finance and Accounting Using a Microcomputer, various sites throughout the U.S. This three-day seminar is sponsored by the Data Processing Institute of the New York University School of Continuing Education. It will cover microcomputer applications for effective decision making and controlling business requirements. Previous computer knowledge is not required. The fee for the course is $695. For specific dates and locations, contact the NYU School of Continuing Education Seminar Center, 575 Madison Ave., New York, NY 10022, (212) 748-5094.

January-April

Courses in C Language and Unix, various sites throughout the U.S. Three five-day courses are offered: "C Programming Workshop," "Advanced C Topics Seminar," and "Unix Workshop." For complete details, contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.

January-August

Conferences and Expositions from the Society of Manufacturing Engineers, various sites throughout the U.S. and around the world. More than 25 conferences and expositions are scheduled. For a calendar, contact the Public Relations Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

January 10-12

Mainframe Seismic and Remote Sensing Applications of Optical Storage, Westin Oaks Hotel, Houston, TX. This conference will emphasize the uses of optical storage in oil exploration, geophysical, atmospheric, and oceanographic-sensing industries, where massive amounts of data must be collected, analyzed, and archived. The fee is $695 for the first person from an organization and $595 for each additional attendee. For details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114-0817, (415) 626-1133.

January 14-15

The Fourth Annual Computer Fair, Northland Mall, Sterling, IL. This event is sponsored by the Sauk Valley Computer Club. For details, contact Vinus Williams, Rt. 1, Milledgeville, IL 61051, (815) 625-8585 days.

January 16-17

Data Communications for Personal Computers, Boston, MA. This seminar seeks to impart an understanding of the fundamentals of data communications, describe the possible applications available to computer users, and provide guidance in the selection and use of data communications hardware and software. Topics covered range from electronic mail to troubleshooting an installed system. The fee is $545, which includes all materials. Contact the Center for Advanced Professional Education (CAPE), Suite 110, 1820 East Garry St., Santa Ana, CA 92705, (714) 261-0240.

January 16-17

MOS Analog/Digital Interface Circuit Design for VLSI Systems, San Francisco Airport Hilton Hotel, San Francisco, CA. This short course will emphasize applicable design techniques for very large-scale integration systems. Course notes are included in the $450 fee. For a brochure, contact Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

January 16-20

The IEEE Instrumentation and Measurement Technology Conference and **The Measurement Science Conference**, Long Beach, CA. Both of these conferences address the theme "Automation—Quality—Productivity." Tutorials, seminars, and workshops will cover such topics as "Design for Testability," "Solid State Transducers," and "Testing Relating to VLSI Design." The first conference will emphasize automated testing and computer-aided instrumentation, while the second focuses on the latest developments in metrology. The venue for both convocations is aboard the Queen Mary ocean liner. For more information, contact John C. Schulz, Ford Aerospace and Communications Corp., Ford Rd., POB A, Building 4, Room 28, Newport Beach, CA 92660, (714) 720-4787.

January 17-19

The Midwestern Telecommunications Showcase, Bartle Hall, Kansas City, MO. Technical sessions and a large exhibition of products and services designed for the telecommunications industry are planned. For details, contact the United States Telecommunications Suppliers Association (USTSA) Exhibit Office, 7076 Taft St., Hollywood, FL 33024, (305) 963-1485.

January 17-19

Mini/Micro-Southeast and **Southcon/84 High-Technology Electronics Exhibition and Convention**, Orange County Convention/Civic Center, Orlando, FL. Mini/Micro, designed for the original equipment manufacturing community, explores peripherals, processors, data communications, and software. A few of the topics to be addressed at Southcon/84 are artificial intelligence, computer-aided design, and factory automation. For details on these concurrent events, contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

January 17-20

Uniforum, Washington-Hilton, Washington, DC. This conference and exposition is designed for and by users of Unix-based systems. For details, contact Mark Weber, Professional Exposition Management Co. Inc., Suite 205, 2400 East Devon Ave., Des Plaines, IL 60018, (800) 323-5155; in Illinois, (312) 299-3131.

January 18-23

Commtex International and **NAVA/ICIA '84 Convention**, Dallas Convention Center, Dallas, TX. Commtex, a communications and information technologies exposition, highlights the latest developments in audio-visual, video, and microcomputer products for many communication needs. The concurrent convention is sponsored by the National Audio Visual Association/International Communications Industries Association (NAVA/ICIA). For information, contact Robert Milko, NAVA, 3150 Spring St., Fairfax, VA 22031, (703) 273-7200.

January 19

Microtrends Update, Dallas, TX. This conference focuses on future trends in the microcomputer industry and on the needs in the educational software field. It's held in conjunction with the NAVA/International Communications Industries Association 1984 Convention. For information, contact Kathy Eisenrauch, NAVA/ICIA, 3150 Spring St., Fairfax, VA 22031, (703) 273-7200.

January 19-20

Data Communications for Personal Computers, New Brunswick, NJ. For details, see January 16-17.

January 23-25

Teaching Math with Microcomputers, Hacienda Resort Hotel, Las Vegas, NV. This seminar, sponsored by the National Council of Teachers of Mathematics (NCTM), is designed to inform educators in elementary, intermediate, and secondary schools about using microcomputers effectively in mathematics education. For details, contact NCTM Seminar Series, 1906 Association Dr., Reston, VA 22091, (703) 620-9840.

January 24-26

Advanced Semiconductor Equipment Exposition (ASEE) and **Technical Conference**, Convention Center, San Jose, CA. Five sessions designed as a broad-based program cover the manufacturing aspects of the semiconductor industry. For details, contact Joyce Estill, Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

January 25-27

The Business Telecommunications Exposition, Stadium Club, Giants Stadium, East Rutherford, NJ. This communications exposition is designed for business, industry, and trade. Topics of interest include facsimile, voice, video, and data communications. Other topics to be covered are office automation, word processing, and purchasing. Registration is required for admittance to the exposition. Contact Michael Houston, The Exposition Group Inc., 9128 Columbia Ave., North Bergen, NJ 07047, (201) 662-1318.

January 25-27

Fundamentals of Digital Electronics: A Hands-on Workshop, Hilton Hotel, Los Angeles, CA. Technical managers and engineers will explore the practical essentials of digital theory and applications. This seminar is sponsored by *Electronics* magazine, a McGraw-Hill publication. In-house presentations can be arranged. For a catalog outlining seminars, locations, and fees, contact Irene Parker, McGraw-Hill Seminar Center, Suite 603, 331 Madison Ave., New York, NY 10017, (212) 687-0243.

January 26–27

Computers in Construction, Las Vegas, NV. This seminar is designed to assist construction contractors and construction management firms in acquiring computer systems. The fee is $425 per registrant. More details are available from CIP Information Services Inc., 1105-F Spring St., Silver Spring, MD 20910, (301) 589-7933.

January 26–27

Software Business Opportunities in Japan, Monterey, CA. This seminar will cover the marketing of packaged software in Japan, software licensing, protecting software from competitors, methods of distribution, tax planning considerations, and sales techniques. American and Japanese computer, technology, trade, and legal experts will discuss strategies for penetrating the Japanese market. Registration information is available from the Technology Analysis Group Inc., Suite 101, 1424 16th St. NW, Washington, DC 20036, (202) 483-6642.

January 27-29

Resource '84, Shamrock Hilton Hotel, Houston, TX. This computer exposition is dedicated to users in the medical, dental, legal, and accounting professions who need to buy a new system or want to upgrade existing systems. Telecommunications information and software applicable to home and office uses will be displayed. Admission is free for physicians, dentists, attorneys, and accountants; all others pay $2.50. Entrance to any or all of the seminars is $10. For details, contact Joyce Fadem, Professional Resources Inc., POB 740433, Houston, TX 77274.

January 30-31

Data Communications for Personal Computers, Los Angeles, CA. For details, see January 16-17.

January 31-February 3

The Sixth Annual Communication Networks 1984 Conference and Exposition, Washington Convention Center, Washington, DC. Voice and telecommunications, electronic mail, data processing, and communications are a few of the products and services to be displayed at this event. Registration information is available from Louise Myerow, POB 880, Framingham, MA 01701, (800) 225-4698; in Massachusetts, (617) 879-0700.

February 1984

February–April

Courses from Integrated Computer Systems, various sites throughout the U.S. "Implementing Local Area Networks" and "Computer Network Design and Protocols" are two of the courses to be presented. For complete course information, contact Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (213) 450-2060.

February–July

Reliability and Maintainability Engineering Institutes and Short Courses, various sites throughout the U.S. A few of the programs to be offered are "Reliability Engineering, Testing, and Maintainability Engineering" and "The Tenth Annual Reliability Testing Institute." For a complete schedule, contact Dr. Dimitri Kececioglu, College of Engineering, Aerospace and Mechanical Engineering Department, University of Arizona, Tucson, AZ 85721, (602) 621-2495.

February 1-2

Data Communications for Personal Computers, San Jose, CA. For details, see January 16-17.

February 2-4

The Third Annual SCS Multiconference, Bahia Hotel, Mission Bay, San Diego, CA. This conference, sponsored by the Society for Computer Simulation (SCS), is composed of four conferences: Modeling and Simulation on Microcomputers, Simulation in Health Care Delivery Systems, Aerospace Simulation, and Simulation in Strongly Typed Languages, Ada, Pascal, Simula. For details, contact Gloria Rico, SCS, POB 2228, La Jolla, CA 92038, (619) 459-3888.

February 7-9

Florida Agribusiness Computer Conference and Trade Show, Civic Center, Lakeland, FL. This conference will demonstrate how computers can be used as decision-making tools for managers in agribusiness. The sponsor of this second annual farm computer conference is the University of Florida's Institute of Food and Agricultural Sciences (IFAS). For details, contact IFAS Director of Conferences, 1041 McCarty Hall, University of Florida, Gainesville, FL 32611, (904) 392-5930.

February 7-10

Florida Instructional Computing Conference, Orlando, FL. This conference is designed to provide kindergarten, elementary school, high school, and college and university instructors and administrators with the opportunity to learn about administrative and instructional computing. More than 85 concurrent sessions, 120 exhibits, and preconference workshops will be offered. Full details are available from Educational Technology, Florida Department of Education, Knott Building, Tallahassee, FL 32301, (904) 487-3104.

February 13-16

Kuwait Info '84, International Exhibition Center, Kuwait City, Kuwait. Exhibits in this third annual event will encompass a broad range of information businesses, including data and word processing, communications, office automation, micrographics, security systems, and environmental control systems. Information is available from Carol Purdey, Intermarket Network Corp., Suite 203, 1110 Vermont Ave. NW, Washington, DC 20005, (202) 822-9127.

February 14-15

The First Annual Automated Manufacturing Systems Conference: A Market Assessment, Inn of Westchester, White Plains, NY. For information, contact Carol Sapchin, Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.

February 14-16

The Twelfth Annual ACM Computer Science Conference, Franklin Plaza Hotel, Philadelphia, PA. Papers, panel sessions, and abstracts will address the central themes of "Factory of the Future," "Coping with Small Computers," and "Social and Ethical Implications of Computers." Exhibits will feature over 50 computer and instructional materials. Particulars are available from the Association for Computing Machinery, 1133 Avenue of the Americas, New York, NY 10036, (212) 265-6300.

February 20-22

The 1984 Office Automation Conference (OAC '84), Convention Center, Los Angeles, CA. The theme of this conference is "Office Automation and You." For the first time, an executive-only program will be offered. Further information is available from the American Federation of Information Processing Societies Inc., 1899 Preston White Dr., Reston, VA 22091, (703) 620-8926. For details on the Executive Program, contact John J. Connell, Office Technology Research Group, POB 65, Pasadena, CA 91102.

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ML-92P, 160 CPS, 80 col., friction & tractor feed, (parallel) $499
ML-93P, 160 CPS, 136 col., tractor & friction feed, (parallel). . . .$849

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40 CPS daisywheel (parallel) $1,089
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13 CPS daisywheel printer, 2-color printing, 3K buffer, (parallel) .$Call

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18 CPS daisywheel, 13" platen, 2K buffer, 3-pitch, (parallel). $539

FUJITSU SP-830

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above plus game port	$262	$302	$352	$402	$452	$502	$552

MegaPlus II Cards

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w/either parallel or serial port No. 2	$274	$314	$364	$414	$464
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USI PI-3, 12" amber, 1,000-dot, 20 Mhz. $169

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Tandon Half-Height, DSDD 320K $219
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Panasonic half ht. DSDD 320K . $189

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Multiplan	$275	$175
PFS: File		$95
PFS: Report		$85
Versaform	$389	$249
PeachPak (GL/AR/AP)	$395	$239
Peach Text 5000		$237
The Tax Manager	$250	$179
VisiCalc/256K	$250	$169
Real Estate Analyzer	$250	$189
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February 20-23

Arabian Productivity Advancement Using Computers/Graphics, APAC '84, Inter-Continental Hotel, Riyadh, Saudi Arabia. This is the first international conference and exposition on computer graphics to be held in Saudi Arabia. Industry and government representatives from Middle Eastern and Western nations will attend. For information, contact APAC '84 Conference Director, World Computer Graphics Association Inc., Suite 399, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

February 21-23

Softcon, Superdome, New Orleans, LA. This international software conference and trade fair is designed for retailers, independent sales organizations, consultants, government agencies, educational institutions, and professional software developers. Registration is $15. For information, contact Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

February 22-28

Imprinta 84, Fairgrounds, Dusseldorf, West Germany. This international congress and exhibition will feature techniques and services in print communication and its alternatives. For details, contact Dusseldorf Trade Shows, 500 Fifth Ave., New York, NY 10110, (212) 840-7744.

February 23-24

Computers in Construction, Orlando, FL. For details, see January 26-27.

February 23-26

Technology, Entertainment, Design Communications Conference, Conference Center, Monterey, CA. Audio and visual presentations documenting technological advances and their usage in communications processes will be presented at this conference. Registration fees are $475. Contact Judi Skalsky, T. E. D. Communications Conference, 635 Westbourne Dr., Los Angeles, CA 90069, (213) 854-6307.

February 27-March 2

MICAD '84, Paris, France. An exhibition associated with the MICAD biennial conference will be held for the first time. This event also marks the tenth anniversary of MICADO, the French Computer Graphics Association. MICAD will provide an opportunity for manufacturers of computer graphics hardware and software to make contact with the rapidly growing French computer-graphics market. For information, contact Caby Smith, World Computer Graphics Association Inc., Suite 399, 2033 M St. NW, Washington, DC 20036, (202) 775-9556. In Europe, contact MICADO, ZIRST, Chemin de Pre Carré, 38240 Meylan, France; tel: (76) 90-31-90; Telex: 980 882 F.

February 27-March 2

Welcome to the World of Personal Computing, Fort Lauderdale, FL. This workshop serves as a comprehensive introduction to the uses of microcomputer technology in business, industry, and government. Six modules, ranging from user productivity to software reliability, are on the agenda. For further information, contact Keston Associates, 11317 Old Club Rd., Rockville, MD 20852, (301) 881-7666.

February 28-29

The Twelfth Annual Midwest Digital Equipment Exhibit and Seminar, Thunderbird Motel, Minneapolis, MN. More than 100 manufacturers of computer terminals, data communications equipment, peripherals, data-acquisition systems, and digital test instruments will display their products. Admission to both the exhibits and seminars is free of charge. For more details, contact Countryman Associates Co., 1821 University Ave., St. Paul, MN 55104, (612) 645-9151.

February 28-March 1

The Annual Computer Fair of the Computer Society of Bermuda, Princess Hotel, Southampton, Bermuda. The theme for this event is "Bermuda—The International Offshore Software Mart." Seminars, demonstrations, presentations, and vendor exhibits will highlight this show. For full details, contact James H. Young Jr., Computer Society of Bermuda, POB 1479, Hamilton 5, Bermuda, (809) 295-7111.

February 28-March 2

The Air Force Conference on Technology in Training and Education, School of Health Care Sciences, Sheppard Air Force Base, TX. This conference will explore technology in aerospace applications, technical training, and education with emphasis on current developments in the Department of Defense. Topics of discussion include computer-generated simulations and training aids and innovative uses of interactive video disks. For information, contact Captain Jim Campbell, SHCS/USAF/MSSA, SAFB Wichita Falls, TX 76311, (817) 851-6461.

March 1984

March 8-9

Computers in Construction, San Diego, CA. For details, see January 26-27.

March 8-10

The Role of the Microcomputer in Education IV, Arlington Park Hilton, Arlington Heights, IL. In-depth seminars and sessions covering a wide range of educational topics make up this conference. Further information is available from Rick Nelson, Micro-Ideas, 1335 North Waukegan Rd., Glenview, IL 60025, (312) 998-5065.

March 12-14

Auditing and Controlling Microcomputers, Houston, TX. This seminar reviews the technology behind microcomputers and shows how they can be used by an auditor for practice management or as a tool in an audit engagement. For a course outline, contact Miriam Hoyt, MIS Training Institute Inc., 4 Brewster Rd., Framingham, MA 01701, (617) 879-7999.

March 12-15

Interface '84, Convention Center, Las Vegas, NV. For details on this twelfth annual data communications/information-processing conference and exposition, contact the Interface Group Inc., 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

March 13-15

Micro/SET 84: Microcomputer Expo for Scientific, Engineering, and Technology, Engineering Society of Detroit, MI. Papers emphasizing microcomputer applications in research, design, engineering, and manufacturing will be presented. Complementing the conference program will be displays of scientific, engineering, and technical microcomputer hardware and software. For more information, write to the Conference Manager, Engineering Society of Detroit, 100 Farnsworth, Detroit, MI 48202.

March 13-15

Optical Storage of Documents and Images, Biltmore Hotel, Los Angeles, CA. Topics to be covered are read-write and read-only storage of analog and digital information including office documents, engineering drawings, and parts catalogs. The fee is $695 for the first person from an organization and $595 for each additional attendee. For more information, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114-0817, (415) 626-1133.

March 18-22

Saudicomputer '84—The Business Computer Show, al-Dhiafa Exhibition Centre, Riyadh, Saudi Arabia. For information, contact Philip Jenkinson, Saudicomputer '84, Overseas Exhibition Services Ltd., 11 Manchester Square, London W1M 5AB, England; tel: 01-486 1951; Telex: 24591 Montex G.

March 19-22

Automated Manufacturing Conference and Exhibition (AM84), Textile Hall, Greenville, SC. The latest automated manufacturing technologies will be the focus of this combination exhibition and seminar. Representatives from more than 200 firms are expected. Complete details about the conference can be obtained from the AM84 Registration Control Center, POB 5616, Station B, Greenville, SC 29606, (803) 242-3170, ext. 260. Details about the exhibition are available from AM84, POB 5823, Greenville, SC 29606, (803) 233-2562.

March 19-22

The Eighth Annual Federal Office Systems Expo (FOSE '84), Convention Center, Washington, DC. The theme for this year's expo is the "Realities of Integration: Technologies, Applications, Human Resources." More than 60 conference sessions and 1200 exhibits are planned. Address inquiries to Jacqueline Voigt, National Trade Productions, 9418 Annapolis Rd., Lanham, MD 20706, (800) 638-8510; in Maryland, (301) 459-8383.

March 22-23

Computers in Construction, New York, NY. For details, see January 26-27.

March 26-28

The Seventh International Conference on Software Engineering, Orlando, FL. This conference seeks to evaluate what has been learned from the past and to provide directions for future investigations in software engineering. Its theme is "Fifteen Years of Software Engineering: Results and Futures." A software tools fair will be held concurrently. Contact the IEEE Computer Society, POB 639, Silver Spring, MD 20901, (301) 589-3386.

March 26-30

The Sixth NC Industrial Automation and Robot Conference and Exhibition, Milan Fair, Milan, Italy. Controls for automated material handling, variable mission manufacturing systems, and quality control will be featured. A concurrent conference consisting of 20 sessions will be presented. For more information, contact the Society of Mechanical Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0023.

March 28-30

The Sixth Annual Computer Graphics Conference, Doral Hotel On-the-Ocean, Miami Beach, FL. The theme for this conference is "Forecasts and Assessments." Further details are available from Carol Sapchin, Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.

March 30-31

Third Annual Conference on Communication Technology, Joseph Stokes Auditorium, Children's Hospital of Philadelphia, Philadelphia, PA. This program presents advances in technology and treatment alternatives for physically handicapped and speech impaired persons. Speakers, equipment demonstrations, and workshops are planned. The two-day registration fee is $95, which includes all course materials. If your registration request is postmarked before March 10, the fee is reduced by $10. Group rates are offered. For full particulars, contact Joan Bruno, Children's Seashore House, 4100 Atlantic Ave., POB 4111, Atlantic City, NJ 08404, (609) 345-5191, ext. 278.

March 30-April 1

The NY Personal Computer Show, Exposition Rotunda, Madison Square Garden, New York City. Formerly called the Eighty/Apple/PC Computer Show, this event will feature products and services for all small computer systems. More than 240 exhibitors are expected. Complete show details can be obtained from the Kengore Corp., POB 13, Franklin Park, NJ 08823, (201) 297-2526. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc., notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock, NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

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Books Received

Apple II BASIC—Quick Reference Guide, Gilbert Held. New York: John Wiley & Sons, 1983; 1 page, 15.5 by 30 cm, fold-out card, ISBN 0-471-87039-0, $2.95.

Atari BASIC—Quick Reference Guide, Gilbert Held. New York: John Wiley & Sons, 1983; 1 page, 15.5 by 30 cm, fold-out card, ISBN 0-471-87041-2, $2.95.

Catching up with the Computer Revolution, Lynn M. Salerno, ed. New York: John Wiley & Sons, 1983; 544 pages, 17 by 24 cm, hardcover, ISBN 0-471-87594-5, $22.95.

The Compleat Computer, 2nd ed. Dennie and Cynthia Van Tassel. Chicago, IL: Science Research Associates, 1983; 282 pages, 30.5 by 22.5 cm, softcover, ISBN 0-574-21415-1, $14.95.

Computer Images, State of the Art, Joseph Deken. New York: Stewart, Tabori & Chang Publishers Inc., 1983; 200 pages, 24.8 by 24.8 cm, softcover, ISBN 0-941434-40-0, $16.95.

Data and File Management for the IBM Personal Computer, John P. Grillo and J. D. Robertson. Dubuque, IA: Wm. C. Brown Company Publishers, 1983; 208 pages, 21.3 by 28 cm, spiral-bound, ISBN 0-697-09987-3, $16.95.

Database Design, 2nd ed. Gio Wiederhold. New York: McGraw-Hill, 1983; 767 pages, hardcover, ISBN 0-07-070132-6, $32.

Designing With Programmable Array Logic, 2nd ed. The Technical Staff of Monolithic Memories Inc. New York: McGraw-Hill, 1983; 690 pages, 19.5 by 24.5 cm, hardcover, ISBN 0-07-042723-2, $32.95.

Electronic Instrumentation and Measurements, David A. Bell. Reston, VA: Reston Publishing Co., 1983; 544 pages, 18.5 by 24 cm, hardcover, ISBN 0-8359-1669-3, $25.95.

Fifty 1K/2K Games for the ZX-81 and Timex Sinclair 1000, Alastair Gourlay, James Walsh, and Paul Holmes. Reston, VA: Reston Publishing Co., 1982; 112 pages, 15.8 by 23.5 cm, hardcover, ISBN 0-8359-1979-X, $10.95.

54 Visicalc Models, Robert H. Flast. Berkeley, CA: Osborne/McGraw-Hill, 1983; 288 pages, 21 by 27.5 cm, softcover, ISBN 0-33134-100-2, $12.95.

Free to Teach, Achieving Equity and Excellence in Schools, Joe Nathan. New York: Pilgrim Press, 1983; 201 pages, 16 by 25 cm, hardcover, ISBN 0-8298-0657-1, $14.95.

IBM PC BASIC—Quick Reference Guide, Gilbert Held. New York: John Wiley & Sons, 1983; 1 page, 15.5 by 30 cm, fold-out card, ISBN 0-471-87042-0, $2.95.

Image Sequence Processing and Dynamic Scene Analysis, T. S. Huang, ed. New York: Springer-Verlag Inc., 1983; 760 pages, 17 by 25 cm, hardcover, ISBN 0-387-11997-3, $59.20.

Interfacing to Microprocessors, J. C. Cluley. New York: McGraw-Hill, 1983; 168 pages, 16 by 24 cm, hardcover, ISBN 0-07-011409-9, $24.50.

Intermediate-Level Apple II Handbook, David L. Heiserman. Indianapolis, IN: Howard W. Sams & Co., 1983; 328 pages, 15.3 by 23 cm, spiral-bound, ISBN 0-672-21889-5, $16.95.

International Microcomputer Dictionary, Berkeley, CA: Sybex, 1981; 142 pages, 10.5 by 16.5 cm, softcover, ISBN 0-89588-067-9, $3.95.

The Intimate Machine, Close Encounters with Computers and Robots, Neil Frude. New York: New American Library, 1983; 256 pages, 14.5 by 22.5 cm, hardcover, ISBN 0-453-00450-4, $15.50.

Introduction to Graphics for the IBM Personal Computer, John P. Grillo and J. D. Robertson. Dubuque, IA: Wm. C. Brown Company Publishers, 1983; 144 pages, 21.3 by 28 cm, spiral-bound, ISBN 0-697-09989-X, $15.95.

M6805 HMOS M146805 CMOS Family, 2nd ed. Motorola. Englewood Cliffs, NJ: Prentice-Hall, 1983; 272 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-541375-3, $17.95.

Machine & Assembly Language Programming, David C. Alexander. Blue Ridge Summit, PA: Tab Books, 1982; 210 pages, 13 by 21 cm, softcover, ISBN 0-8306-1389-7, $9.95.

Managing the Data-Base Environment, James Martin. Englewood Cliffs, NJ: Prentice-Hall, 1983; 784 pages, 19 by 24 cm, hardcover, ISBN 0-

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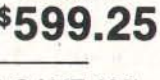

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13-550582-8, $49.95.

Messner's Introduction to the Computer, Fred D'Ignazio. New York: Simon & Schuster, 1983; 288 pages, 14.5 by 21.5 cm, hardcover, ISBN 0-671-42267-7, $10.29.

Microcomputer Interfacing, Harold S. Stone. Reading, MA: Addison-Wesley, 1983; 400 pages, 16.5 by 24 cm, hardcover, ISBN 0-201-07403-6, $32.95.

Microelectronics and Office Jobs, Diane Werneke. Washington, DC: International Labor Office, 1983; 108 pages, 16 by 24 cm, softcover, ISBN 92-2-103278-7, $10.

Modern Methods for COBOL Programmers, John R. Pugh and Doug H. Bell. Englewood Cliffs, NJ: Prentice-Hall, 1983; 224 pages, 16 by 24 cm, hardcover, ISBN 0-13-595215-8, $17.95.

Photovoltaics, Robert G. Seippel. Reston, VA: Reston Publishing Co., 1983; 256 pages, 18 by 24 cm, hardcover, ISBN 0-8359-5538-9, $22.95.

Practical Digital Design Using ICs, 2nd ed. Joseph D. Greenfield. New York: John Wiley & Sons, 1983; 736 pages, 16.5 by 24.5 cm, hardcover, ISBN 0-471-05791-6, $26.95.

Programming in Pascal, C. William Gear. Chicago, IL: Science Research Associates, 1983; 256 pages, 18.5 by 23.5 cm, softcover, ISBN 0-574-21360-0, $14.95.

Programming the IBM Personal Computer: Fortran 77, Robert Rouse and Thomas Bugnitz. New York: Holt, Rinehart and Winston, 1983; 256 pages, 17.5 by 23.3 cm, softcover, ISBN 0-03-062042-2, $35.95.

Programming Your Atari Computer, Mark Thompson. Blue Ridge Summit, PA: Tab Books, 1983; 280 pages, 13 by 21 cm, softcover, ISBN 0-8306-1453-2, $10.95.

Software Engineering for Small Computers, R. B. Coats. Reston, VA: Reston Publishing Co., 1982; 256 pages, 18 by 24 cm, hardcover, ISBN 0-8359-7026-4, $24.95.

Strategies for Natural Language Processing, Wendy G. Lehnert and Martin H. Ringle, eds. Hillsdale, NJ: Lawrence Erlbaum Associates Inc., 1983; 560 pages, 16 by 23.5 cm, hardcover, ISBN 0-89859-191-0, $49.95.

A Structured Approach to Fortran, J. Winston Crawley and Charles E. Miller. Reston, VA: Reston Publishing Co., 1983; 766 pages, 19 by 24 cm, hardcover, ISBN 0-8359-7092-2, $16.95.

Techniques of BASIC for the IBM Personal Computer, John P. Grillo and J. D. Robertson. Dubuque, IA: Wm. C. Brown Company Publishers, 1983; 270 pages, 21.3 by 28 cm, spiral-bound, ISBN 0-697-08276-8, $18.95.

Useful BASIC Programs for the IBM PC, Stanley R. Trost. Berkeley, CA: Sybex, 1983; 192 pages, 14 by 21 cm, softcover, ISBN 0-89588-111-X, $8.95.

User's Guide with Applications for the IBM Personal Computer, John P. Grillo and J. D. Robertson. Dubuque, IA: Wm. C. Brown Company Publishers, 1983; 272 pages, 21.3 by 28 cm, spiral-bound, ISBN 0-697-09985-7, $17.95.

Using and Troubleshooting the MC68000, James W. Coffron. Reston, VA: Reston Publishing Co., 1983; 224 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-8359-8158-4, $21.95.

VisiCalc Advanced Version, Worksheets for Business, Van Wolverton. San Jose, CA: Visicorp, 1983; 256 pages, 19 by 23 cm, softcover, ISBN 0-912213-00-0, $18.95.

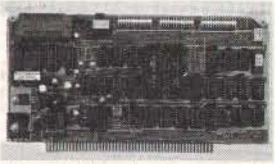
VisiCalc for Science and Engineering, Stanley R. Trost and Charles Pomernacki. Berkeley, CA: Sybex, 1983; 224 pages, 17.7 by 22.8 cm, softcover, ISBN 0-89588-096-2, $13.95.

What Can I Do With My Timex/Sinclair 1000? Lots!, Roger Valentine. New York: John Wiley & Sons, 1983; 164 pages, 17 by 25.5 cm, softcover, ISBN 0-471-88730-7, $9.95.

Z80 Applications, James W. Coffron. Berkeley, CA: Sybex, 1983; 320 pages, 17.5 by 22.5 cm, softcover, ISBN 0-89588-094-6, $14.95.■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

Extended Processing S100 Boards



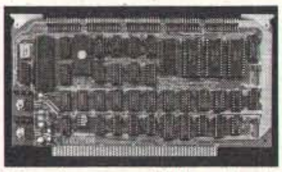
BURNER I/O

The BURNER I/O is a full feature multifunction S100/IEEE-696 board. It has a complete EPROM programmer, 2 Serial ports, parallel output port, parallel input port and memory management. Programs 2704 thru 2764, 2508, 2516 and TMS2716 EPROMS. Menu driven disk based software supplied in 4K EPROM that is easily loaded on your disk. Zero insertion force programming socket. Totally I/O mapped. Serial ports are independent and support hardware handshaking. Baud rates from 50–19,200. Serial ports are software programmable. Seperate parallel input and output ports with full handshaking plus 4 direct sense bits. Memory management controls the S-100 address lines A16-A23.

The board is offered in various configurations. In all versions it is fully assembled and tested.

Option A: Complete board with programmer, I/O and memory management, $354.95
Option B: Programmer only, $219.95
Option C: I/O only (2S + P), $219.95
Option D: Options B and C, $329.95
Option E: Memory management only, $109.95

Memory management may be added to Options B and C for $25.00



POWER I/O

The POWER I/O is a high performance slave computer that is a complete system including all hardware, software and documentation. It is guaranteed to operate properly with *any* S-100/IEEE-696 system. The POWER I/O sets a new standard in flexibility, ease of integration, expandability and performance. It is designed with the future in mind. All I/O and memory may be doubled with the addition of our POWER I/O add-on. Memory can be quadrupled when the 256k rams are available. The standard software supports 6 serial ports, 2 parallel ports and 512K of ram.

The basic board consists of a 4MHz Z80A, 64K DRAM, 3 serial (8251A) I/O ports, baud rates to 19,200. Hardware, ETX, ACK and X-on/X-off handshaking, 1 parallel port, timer, 6 programmable delays, high speed parallel I/O to host, complete POWER I/O software in 4K EPROM (expandable to 8K). On board software is designed for maximum flexibility and ease of use. Supports user written programs. Complete documentation including source code, schematics and many software interface examples.

The POWER I/O add-on has 3 additional serial ports, 1 parallel port and 64K DRAM.

POWER I/O: $375.00
64K RAM ADD-ON: $175.00
3 SERIAL, 1 PARALLEL ADD-ON: $195.00
RAM AND I/O ADD-ON: $295.00

ep Extended Processing 3861 Woodcreek Lane ■ San Jose, California, 95117 ■ (408) 249-8248

Circle 158 on inquiry card.

Clubs and Newsletters

Exchanges via Newsletter

Electronics Projects is a newsletter for the exchange of projects, technical articles, software, computer applications, programming tips, and money-making opportunities. All members of the Electronics Projects Club can receive free advertising and are encouraged to submit articles in any electronics area. A $15 membership fee includes a subscription to eight issues of *Electronics Projects*. For information, send a self-addressed, stamped envelope to Kamenar Enterprises, POB 186, Hatboro, PA 19040.

Unigroup of Manhattan

Unigroup is a nonprofit organization for users of the Unix operating system and its related products that meets in the New York metropolitan area. Meetings are held every two months and feature speakers who are prominent in the Unix field. Membership is $25 a year and includes a subscription to the newsletter *Unigroup Journal*. Nonmembers must pay $10 to attend meetings, which are open to all interested people. Address applications and inquiries to Unigroup of New York Inc., GPO Box 1931, New York, NY 10116.

New Englanders Organize for Osbornes

The Vermont—New Hampshire Osborne Users Group (VNHOG) meets once a month at the Universalist Church in Woodstock, Vermont. Osborne users and other interested people are welcome to attend meetings. Topics include database-management programs, Supercalc spreadsheets, Wordstar-Mailmerge word processing, and more. For details, contact VNHOG, RFD 1, Box 20A, Killington, VT 03751, or call Solveig Overby at (802) 422-3667.

Monthly Review for the 64

The 64 Review is a monthly newsletter for users of the Commodore 64 personal computer. Features of the newsletter are a question-and-answer column, programs, a technical column, information on graphics and sound, and more. Annual subscriptions are $11.95. Sample issues cost $2.50. For further information, write to *The 64 Review*, POB 322, Livermore, CA 94550.

IBM PC Users Meet in Fresno

The Fresno IBM PC Users Club meets monthly in Fresno, California, to discuss intricacies of the PC. The club's newsletter announces the times and locations of future meetings, contains a trade column, and informs users of the IBM PC about events of interest. For further details, contact R. Betancourt, Fresno IBM PC Users Club, 6750 North Woodrow Ave., Fresno, CA 93710.

Tribune for CP/M Users

The CP/M Houston Users Group, an active group in Houston, Texas, produces a newsletter called the *CP/M Houston Tribune*. The group seeks to educate its members about communications, public-domain software, and video microbroadcasting of software. Other interests include expanding the uses of CP/M-based systems regardless of brands and sharing activities with other user groups. For details on meetings and fees, contact Thomas McCormick, CP/M Houston Users Group, Box 570473, Houston, TX 77257-0473, or call (713) 975-6061.

Computer Cost Estimating

Micapp Inc. (Microcomputer Assisted Process Planning) produces the *Micapp Newsletter* bimonthly for people in the metal-working industry who use microcomputers to perform engineering tasks. Listings for applications such as cost estimating and process planning for turning, drilling, milling, boring, and grinding are included. Subscriptions cost $37.50 a year in the U.S. and $47.50 in Canada and abroad. For details, contact Micapp Inc., 16956 230th Ave., Big Rapids, MI 49307, or call (616) 796-6637.

For the Alpha Micro

The Southern California Alpha Micro Users Society (SC/AMUS) meets on the second Sunday of every month (except holidays) from 1 to 3 p.m. at the Fullerton Savings and Loan, 12860 Euclid in Garden Grove, California. Membership dues are $22 the first year and $12 thereafter for annual renewal of the newsletter. Nonmembers can receive the newsletter for $6 a year; back issues are available. For information, contact Bob Alex, 17632 Fiesta Way, Santa Ana, CA 92705, or call (714) 669-0360.

Comprehensive Tandy Group

The Tandy Business Users Group (T-BUG) meets on the third Wednesday of every month in the Chicago metropolitan area to discuss applications for the TRS-80 Models II, 12, 16, and 16B. A newsletter, *T-BUG*, is produced and is included with the $25 annual membership. It contains information on past and future meetings, software reviews, and a consultant's column. For details, contact Carlos Hidalgo, 311 Longview Rd., Waukegan, IL 60087, or call (312) 623-9661.

Central Jersey Users

The Central Jersey IBM/PC Users (CJPC) is a group designed for users to exchange information about the IBM PC. For information, contact Howard Dean, CJPC, POB 8280, Red Bank, NJ 07701, (201) 842-5800.

TS User Newsletter

TS User is a monthly newsletter for users of the Timex/Sinclair microcomputer and its products. It includes hardware, software, and book reviews, editorials, and other columns for improved applications. Annual subscriptions are $16.95 for 12 issues; $25 outside the U.S. and Canada. *TS User* is available from Yagsee, POB 155, Vicksburg, MI 49097.

Osborne Group in Philadelphia

The Philadelphia Regional Osborne Group (PHROG) meets monthly in the Lansdale area outside Philadelphia to serve those interested in increasing the scope of their Osborne-related endeavors. A newsletter is planned. For details, contact Joe Gervase, PHROG, Box 340, Lamplighter Plaza, Kulpsville, PA 19443, or call (215) 362-1888.

Meet in Miami

The Miami PC User Group meets bimonthly to share experiences and knowledge in the current and future uses of the IBM PC at home and at the office. Members can access a private bulletin board service and a software library. Annual dues are $20. For details, contact Eddy Cue, Miami PC User Group, 6925 Southwest 16 St., Miami, FL 33155, or call (305) 262-1891.

Westchester Apples

The Westchester Apple Users Club meets at 8 p.m. on the third Wednesday of each month to discuss topics of interest to owners of Apple computers. The meetings are open to the public. A fee to cover the cost of club mailings is $11 for adults and $5 for students. For further information, contact Linda Halpern, 330 High Point Dr., Hartsdale, NY 10530, (914) 428-5242.

Engineering Working Group

Educators interested in using microcomputers for engineering purposes are invited to join a nationwide group and receive a quarterly newsletter. For further information, write Marilyn Henry, Microcomputer Engineering Working Group, George Washington University (SEAS), Washington, DC 20052.

Kaypro Club for People in Queens

The Peoples Computer (of Queens) Kaypro Club unites users and promotes useful information about the Kaypro II. An $8 membership fee automatically enters members into a national database, and entitles them to receive a quarterly newsletter. The *Piece of Kayke National Newsletter* could become a monthly newsletter with enough input. For further details, contact Steve Bender, Peoples Computer (of Queens) Kaypro Club, Box 28360, Queens Village, NY 11428.

Telecommunicate the News

Plumb is a newsletter that includes information about electronic bulletin board systems and related communications systems for all types of computers. Stories include news and features about software downloaders, message systems, merchandise boards, and more. For details on current subscription prices, contact *Plumb*, Box 300, Harrods Creek, KY 40027.

Schools Take Note

CHIME, the newsletter of the Clearinghouse of Information on Microcomputers in Education, is produced by the College of Education of Oklahoma State University. It contains software reviews written by teachers about educational programs for languages, sciences, mathematics, statistics, and more. A one-year subscription is $15; additional subscriptions delivered to the same address are available for $10 a year. For details, contact *CHIME*, College of Education, Oklahoma State University, 108 Gundersen, Stillwater, OK 74048, or call (405) 624-6254.■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

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a message to our subscribers

From time to time we make the **BYTE** subscriber list available to other companies who wish to send our subscribers material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

Many **BYTE** subscribers appreciate this controlled use of our mailing list, and look forward to finding information of interest to them in the mail. Used are our subscribers' names and addresses only (no other information we may have is ever given).

While we believe the distribution of this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive such promotional literature. Should you wish to restrict the use of your name, simply send your request to the following address.

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What's New?

SOFTWARE

Time Manager Eyes Expenditures

Time Manager is just one of eight programs in Traveling Software's Business Manager Series for Radio Shack Model 100 and NEC PC-8201 computers. This program records time expenditures for projects, clients, and, if desired, by individual work activity. Hours worked can be logged as either billable or nonbillable with optional standard billing rates generated for work activities. Flexible reporting of summary information can be displayed on screen or printed out in either 40- or 80-column formats.

Time Manager costs $59.95, which includes a tutorial notebook and audiocassette tutorial. The other programs in the Business Manager Series cover appointments, expenses, sales, projects, taxes, and accountant books. A communications program is also available. For more information, call or write Traveling Software Inc., 11050 Fifth Ave. NE, Seattle, WA 98125, (206) 367-8090.

Circle 550 on inquiry card.

Graphics Package Announced by Accent

A graphics creation and animation package for the Apple II or III has been introduced by Accent Software. TGS: The Graphic Solution combines text and graphics in a manner that's similar to cinematic animation techniques. This program provides simple keyboard commands that you wield to build bit-mapped shapes, which are used to create interactive graphics presentations. TGS lets you mingle text and graphics on screen using its resident character set or your own fonts. Special graphics commands can be created with macroinstructions that enable execution of several graphics tasks with a single keystroke. Multiple object and background, variable speed animation, dual low- and high-resolution operation, single-keystroke editing, and hidden line animation are provided.

TGS is fully compatible with graphics programs that permit saving high-resolution screens as standard Apple II DOS 3.3 files. Its hardware requirements are 48K bytes of RAM, Applesoft in ROM, one disk drive, and a monitor. The list price is $149.95. A manual, backup disk, and demonstration applications are supplied. A demonstration disk is available for $10 directly from Accent Software Inc., 3750 Wright Pl., Palo Alto, CA 94306, (415) 856-6505.

Circle 552 on inquiry card.

Program Knocks Spreadsheets on Their Side

Sideways lets you print all the columns of your spreadsheet, all at one time, on one continuous page. This program, developed by Funk Software, causes your hard copy to print out sideways and is compatible with such spreadsheets as Lotus 1-2-3, Visicalc, Multiplan, and Supercalc. Standard printing features include a choice of type sizes ranging from compressed to large, a double-strike mode, unlimited printing width, and adjustable character spacing, line spacing, margins, and print dimensions. Sideways accepts ordinary ASCII textfiles created by spreadsheets, word processors, and editors.

Sideways works with the IBM Personal Computer. It supports such printers as the Epson MX-80/100 and FX-80/100, IBM Graphics Printer, Okidata's Microline series, C.Itoh Prowriter, and Integral Data Systems' Prism, 460, and 560. The suggested retail price is $60. For more information, contact Funk Software Inc., POB 1290, Cambridge, MA 02238, (617) 497-6339.

Circle 558 on inquiry card.

Executive Expense Account Manager

Adaptive Software's Expense Account Manager is purported to be the first microcomputer software package designed specifically to organize and track travel and entertainment expenses for company executives and professionals. Salient features include easy expense entry and corrections, reminders of expenses that are often overlooked, prompting for specific information required by the IRS, and budget projections. Expense subtotals can be organized by client or project, and a table of frequently traveled trips is maintained, which allows easy and consistent reporting of automobile mileage. Expense Account Manager automatically reconciles travel advances and tracks reimbursements. For ad hoc reporting of expense data, an interface to Visicalc is provided. Additional features include the ability to print out pocket recording sheets for recording expenses as they are incurred and the ability to change expense items, budget lines, and subtotal definitions without programming.

The Expense Account Manager runs on 48K-byte Apple II Plus and IIe computers. It requires a disk drive and a printer. The suggested retail price is $150. Contact Adaptive Software, 1868 Cavell Ave., Highland Park, IL 60035, (312) 831-4420.

Circle 556 on inquiry card.

PC Chess Program

The Sfinks PC Chess program is designed for both beginners and experts. Program highlights include a problem mode, infinite levels of play, a dual chess clock, a save and restore function, multiple move take backs, move suggestions, and algebraic notation. Sfinks also has optional printout and audio signal capabilities. All United States Chess Federation rules, such as castling, en passant, and underpromotion, are observed. Monochrome and color graphics are supported.

The Sfinks PC Chess program runs on 64K-byte IBM Personal Computers. It's available on floppy disk for $49.95 plus $2 shipping, from William Fink, Suite 24-B, 1105 North Main St., Gainesville, FL 32601, (904) 377-4847.

Circle 564 on inquiry card.

Multiple Applications on Screen at Once

Jack2 for the IBM Personal Computer lets you do word processing, spreadsheeting, charting, and database-management tasks on screen simultaneously without windows. One feature of Jack2 automatically changes the corresponding values in text or a bar graph when you alter a number in a spreadsheet. All screen data, such as a spreadsheet with explanatory text and a bar chart, can be printed out on a single page in the same manner as it appears on screen. Multiple columns of text can be displayed on the same page. Since wordwrap occurs within individual columns, text can be entered or deleted in any of the columns without affecting the layout of the other columns. Pages can be as large as 25½ inches wide, and horizontal scroll is automatic.

Jack2 spreadsheets can handle 1000 columns and rows, each of which can have as many as 255 values. Numeric values can be stored with up to 24 digits of precision. Additionally, Jack2 offers user-selectable automatic or manual recalculation, user-definable column widths, and right justify, left justify, or center entries. Other features include a two-line command area on top of the screen, a help line that explains what a command does, user-defined database and record formats, charting and printing functions, and the ability to hide a scratchpad and confidential information in text. Fields can be deleted, added, or contracted, and three-level ascending, descending, alphabetic, and numeric sorts are permitted.

Two utility programs, a report generator and a data transfer program, are offered as options. Jack2 costs $495. Contact Business Solutions Inc., 60 East Main St., Kings Park, NY 11754, (516) 269-1120.

Circle 562 on inquiry card.

Accounting Programs for HP 150

BPI Systems announced the availability of a family of accounting packages for Hewlett-Packard's HP 150 personal computer. The packages are General Accounting, Personal Accounting, Accounts Payable, Accounts Receivable, Payroll, Job Cost, and Inventory Control. Each package can be used alone or integrated with other BPI software. The programs come on 3½-inch floppy disks and are supplied with documentation tailored for the HP 150. Each package retails for $425 and is marketed through existing Hewlett-Packard outlets.

BPI Systems also produces software for such computers as the Apple, Commodore 8032, IBM Personal Computer, NEC PC 8000, Sanyo MBC series, Texas Instruments Professional Computer, and CP/M-based systems. Complete details are available from BPI Systems Inc., 3423 Guadalupe, Austin, TX 78705, (512) 454-7191.

Circle 561 on inquiry card.

Prolog Interpreter Runs Under CP/M-80, MS-DOS

Micro-Prolog 3 is an extended Prolog interpreter for Z80-based machines running CP/M-80 and 8088/8086-based machines running MS-DOS. Prolog has enjoyed wide popularity abroad as a development language for intelligent databases, expert systems, and artificial-intelligence applications. Although tailored for microcomputers, Micro-Prolog 3 sacrifices none of the features of Prolog. Program-development aids such as interactive text and structure editors, three trace utilities, and user-definable error trapping and recovery are standard.

Micro-Prolog 3 features user-friendly syntax, tail recursive programs run in bounded memory, a garbage collector, and the ability to wrap completed programs as protected modules that can communicate with other programs by means of import/export name lists. More than 60 primitive relations are provided, some of which include integer and floating-point arithmetic, two-way conversation between constant and character lists, and formatted record I/O for intelligent database applications. Among its new extensions are user-definable commands and the ability to add new primitive relations using an integral systems interface to machine-code programs. Micro-Prolog 3 has an average speed of 240 resolutions per second on a 4-MHz Z80 or 8088 microprocessor.

On CP/M-80 systems, Micro-Prolog 3 requires 48K bytes of memory; MS-DOS systems need 128K bytes. A single license with documentation is $275. Additional computer licenses cost $75. For full details, contact Prolog Systems, 54 Edgemont Rd., Milford, CT 06460, (203) 877-7988.

Circle 563 on inquiry card.

Interactive Sales Aid

GINA is an interactive point-of-purchase sales aid designed to attract, inform, and entertain your customers. GINA (General Information and Analysis) is a self-paced, hands-on tutorial that acquaints customers with computer basics. It uses a simple question-and-answer format that helps to define and clarify customers' computer needs. After collecting data on your customers' needs, GINA presents them with a purchase proposal that is tailored to those needs.

Two versions of the program are available. Standard GINA recommends generic systems, while GINA+ suggests specific brand names that can be geared to your inventory. It runs on the IBM Personal Computer and its compatibles. Either version can also be purchased in almost any CP/M format. GINA costs $295, and GINA+ is $495. For more information, contact System Vision Corp., Suite 207, 199 California Dr., Millbrae, CA 94030, (800) 352-9999; in California, (415) 697-3861.

Circle 559 on inquiry card.

SAT Study Program from Barron's

Barron's Computer Study Program for the SAT is tailored for high school students preparing to take the Scholastic Aptitude Test (SAT). This program purportedly helps students pinpoint academic strengths and weaknesses and prescribes a personalized study program. Four full-length, simulated SATs are provided, each featuring two modes of operation: Question and Test.

For each problem in the Question mode, the computer supplies an explanation of the correct response, an explanation of wrong answers for verbal questions, problem-solving strategies for mathematics questions, and a hint and a second chance to correct wrong answers. The Test mode provides uninterrupted and timed test-taking.

In addition, the program provides students with the number of questions answered correctly and incorrectly, a scaled SAT score, and the percentage of correct answers in 42 skill areas. Complementary workbooks address text, mathematics, and verbal skills. Sound effects and color are featured.

The Computer Study Program for the SAT comprises three double-sided floppy disks, a users manual, and three study guides. Versions are available for IBM PC, Commodore 64, and Apple II, II Plus, and IIe computers. The list price is $79.95. A teacher's disk is offered. For more details, contact Barron's Educational Series Inc., 113 Crossways Park Dr., Woodbury, NY 11797, (516) 921-8750.

Circle 555 on inquiry card.

Utility Recovers Lost Files

You can reconstruct files with bad sectors, recover files from disks with damaged directories, and restore erased files with the Disk Fix-Disk Editor and Recovery Utility from the Software Store. This utility automatically configures itself to floppy or hard disks and can display, edit, or copy any sector of a CP/M 2.0 disk. Other features include menus and on-screen editing in both hexadecimal and controlled ASCII.

Disk Fix works on 8080-, 8085-, or Z80-based computers with CP/M. It costs $150 and is available in most 5¼- and 8-inch formats. For more information, contact the Software Store, 706 Chippewa Square, Marquette, MI 49855, (906) 228-7622.

Circle 553 on inquiry card.

Casino Pac Runs on Commodore 64

Advanced Microware recently introduced Casino Pac for the Commodore 64. Casino Pac includes four gambling games: Blackjack, Poker, Keno, and Slot Machine. Each game is said to be an accurate simulation of the video gaming machines being used in Las Vegas, Reno, and Atlantic City. Casino Pac is available on tape or floppy disk for $39.

64Tour, a grand tour of the features and capabilities of your Commodore, is also available from Advanced Microware. It has demonstrations of all the 64's graphics modes as well as music and sound effects. It costs $12.

Both programs can be obtained from Advanced Microware, POB 6143, Santa Ana, CA 92706, (714) 554-6470.

Circle 565 on inquiry card.

Action Games Set on a River and in Space

Two games for the Commodore 64, River Chase and Galactic Battles, were recently released by Cyberia Inc. In River Chase, you must contend with enemy gunboats and perilous objects as you try to steer your boat safely home. Your fuel and explosives are limited, but you can replenish them at supply depots along the way. River Chase features color graphics, music, and six levels of play.

Galactic Battles is the saga of a space explorer ship that accidentally crosses into a new universe inhabited by an array of aliens. This game gives you three different scenarios to choose from. Graphics and sound effects heighten the action.

Both games require joysticks. They are available on floppy disk or cassette for $19.95 each. For further information, contact Cyberia Inc., POB 784, Ames, IA 50010, (800) 247-3900; in Iowa, (800) 262-2004.

Circle 566 on inquiry card.

Business Graphics Package Runs on Rainbow

A business graphics package from the Redding Group, Graftalk runs on the DEC Rainbow 100. This device-independent software uses English commands interactively, runs commands from disk files, and uses customized or standard menus. It produces exploded pie charts, scatter diagrams, line and combination plots, and stacked, percentage, clustered, and floating bar charts. A range of move, draw, and other graphics and text commands are at your disposal, and a minispreadsheet and a text editor are provided.

Graftalk also supports the IBM PC and Zenith computers. Versions for NEC, Epson, and Victor computers will be available soon. For the DEC Rainbow, Graftalk is priced at $450. For more details, contact the Redding Group Inc., 609 Main St., Ridgefield, CT 06877, (203) 431-4661.

Circle 567 on inquiry card.

Law Office Organizer

The Legal Assistant comprises five programs designed to increase productivity in the law office: Incorporating-by-Reference (IBR), Folio, Footnote, Grammatik, and the Random House Proofreader. IBR can be used for compiling client letters, contracts, wills, and briefs. A database manager, Folio stores and retrieves client records, indexes of legal documents, pleadings and briefs, bibliographies, and article abstracts. Footnote numbers and formats footnotes in Wordstar or Select files. Grammatik and the Random House Proofreader will check your documents for correct grammar and spelling, respectively. In addition, the Proofreader will let you create your own dictionary of legal terms.

These programs are available in most popular microcomputer formats, including CP/M, MS-DOS, and PC-DOS. The Legal Assistant package is $349. For full details, contact Digital Marketing Corp., 2363 Boulevard Circle, Walnut Creek, CA 94595, (415) 947-1000.

Circle 560 on inquiry card.

Model IV CP/M Has Interchange Utility

Montezuma Micro offers an implementation of Digital Research's CP/M 2.2 for the Radio Shack TRS-80 Model IV that has an Interchange utility capable of reading, writing, and copying more than 20 disk formats, including IBM, Kaypro, Osborne, and Xerox. A configuration program for 35-, 40-, 77-, and 80-track single- or double-density drives is built in, as is a utility that can format more than 50 different floppy disks. Additional features include full utilization of function keys, a 4-MHz clock speed, and ADM-3A emulation with reverse video.

Montezuma Micro has compressed the system code for CP/M 2.2 so that it will occupy only the first two tracks of a floppy disk, which leaves 170K bytes for storage. It works with either 64K- or 128K-byte Model IVs. Complete with utilities and a 300-page manual, this DOS costs $199.95. Contact Montezuma Micro, Redbird Airport Hanger #8, Dallas, TX 75232, (800) 527-0347; in Texas, (800) 442-1310.

Circle 554 on inquiry card.

A Fontastic Program for Printers

You can enhance your dot-matrix printouts with diagrams, charts, and special graphics characters with a new program from IHS Systems. Fontastic lets you create and incorporate such diagrams as electrical schematics or bar charts as part of the text in a standard PC-DOS file. A unique feature of this program is a full-screen font-creation utility that lets you change any standard Fontastic font, create new fonts, and add newly designed fonts to the resident library. Word-processing forms control and proportional printing are among Fontastic's other features.

Fontastic works with most popular word processors, including Benchmark, Easywriter 1.1, Peachtext, Volkswriter, and Wordstar. Printers such as the IBM Graphics, Epson MX/FX, C.Itoh Model 8510A, and Okidata Microline are supported. The program is supplied on two floppy disks; one has utilities while the other has more than 20 fonts to get you up and running. Fontastic runs on 128K-byte IBM Personal Computers. Address inquiries to IHS Systems, Suite 211, 4718 Meridian Ave., San Jose, CA 95118, (408) 265-5503.

Circle 551 on inquiry card.

C Compiler for IBM

A full C language compiler for the IBM Personal Computer is available from Sure-Wing Systems. A complete implementation of C as defined by Kernighan and Ritchie, Sure-Wing C has full floating-point mathematics, a complete I/O library, and all standard C language structures, unions, and typedefs. With this two-pass compiler, assembled routines can be linked in and called from C routines. It produces OBJ files compatible with the PC-DOS linker. Program size can be up to 64K bytes of code and 64K bytes of data. The source code for the library functions is provided.

Sure-Wing C runs on the IBM PC or PC XT with 128K bytes of memory and either PC-DOS 1.1 or 2.0. Two 320K-byte floppy-disk drives or a combination of one floppy disk and a hard-disk unit are required. Sure-Wing C costs $100. Updates will be available for $10. A version for 8087-based IBMs is being developed. The compiler can be ordered from Sure-Wing Systems, POB 20008, Oakland, CA 94620, (415) 655-4773.

Circle 557 on inquiry card.

LISP System for TRS-80

A fast machine-language LISP system for users of Radio Shack TRS-80 Models I/III and IV has been announced by Artificial Intelligence Technologies. This system offers standard LISP functions and is enhanced with such features as visual display capability with pixel graphics and cursor addressability, random-access disk I/O, character-oriented I/O capabilities, user-selectable prompt, automatic closing of s-expressions with left and right brackets, abbreviated quoting, floating-point routines, and strings, files, and arrays as additional data types.

The LISP system comes with a manual containing an introduction to LISP fundamentals and detailed coverage of the use of the LISP interpreter, structurally-oriented editor, and the differentiator and algebraic simplifier. A poker player is provided. The system costs $79.95. Full particulars are available from Artificial Intelligence Technologies, 2121 Northeast 152nd, Redmond, WA 98052, (206) 644-3068.

Circle 568 on inquiry card.

Genealogy Program Handles 30 Generations

Cyclone Software's Patriarch I is a comprehensive genealogy system capable of tracking 30 generations. It offers three modes of relationships: that between two people, between one person and all the descendants of another, and all those related in a specific way to one person. Up to 26 children can be entered per person. Patriarch I lets you print family trees and generate an unlimited number of reports with up to 60 print conditions sorted on any of five fields. This fully relational database offers 50 user-definable fields, menu-driven operation, the ability to handle six indexes simultaneously, and the capacity to store 2144 characters per record.

Patriarch I is designed for 48K-byte Apple II Plus and IIe computers equipped with a disk drive and running under DOS 3.3. It costs $195, which includes a manual with tutorials. For complete information and a sample printout, contact Cyclone Software, 3305 Macomb St. NW, Washington, DC 20008, (202) 362-8740.

Circle 569 on inquiry card.

Communications

Hayes Modem Bundled With Software

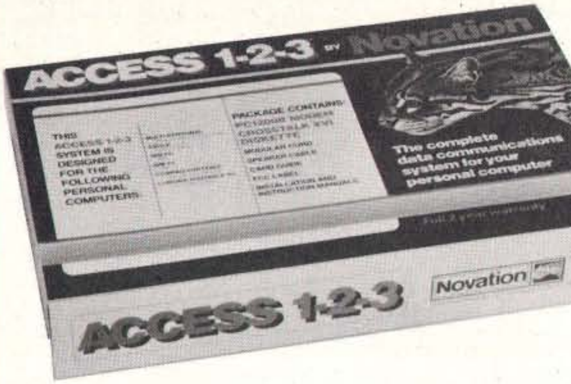
Hayes Microcomputer Products has announced the availability of a modem and communications software package for Apple computers. The Micromodem IIe is a compact modem housed on a circuit board that slides into an Apple's expansion slot. It then connects directly to the telephone line, giving you the ability to communicate with other computers and timesharing and information services. It supports both Touch-Tone and rotary-pulse dialing and single- and multiline telephone connections. A built-in speaker lets you monitor calls as they are being made. Data rates are 110 and 300 bps. Micromodem IIe is Bell 103-type compatible, and it's FCC approved.

The Smartcom I communications software directs the Micromodem to place and answer calls and to send and receive files with any of three transfer protocols, which are stop/start, send lines, and verification for error-free transfers between Hayes's programs. Smartcom routes data to a printer, stores three telephone numbers, and has a comprehensive set of variable communications parameters that are predefined for a common environment. This program will also create, delete, and display files and a directory. It can handle up to six disk drives, several printer cards, 40- and 80-column displays, and lowercase characters.

The suggested retail price for this package is $329. Previous owners of the Micromodem II can obtain Smartcom for $119. Contact Hayes Microcomputer Products Inc., 5923 Peachtree Industrial Blvd., Norcross, GA 30092, (404) 449-8791.

Circle 572 on inquiry card.

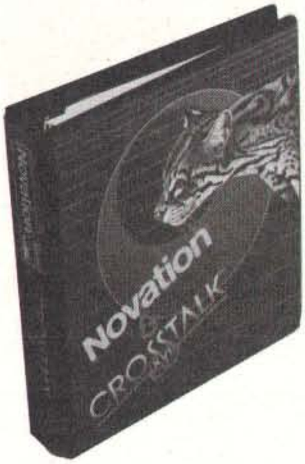
What's New?


ACCESS 1-2-3 BY Novation
The complete data communications system for your personal computer
ACCESS 1-2-3
Novation

Customized Modem/ Software Packages

Access 1-2-3 is a new family of customized data communications packages from Novation. The premiere system is designed for the IBM PC, IBM PC XT, Columbia Data Systems' Portable and Multi Personal Computers, the Corona Portable and Personal Computers, and the Compaq. Access 1-2-3 comprises Novation's PC1200B modem, necessary cables and accessories, and Multistuf's Crosstalk XVI software. Its suggested retail price is $595.

The PC1200B is a smart modem featuring an extensive set of commands and responses that provide telephone line status. It has a built-in dialer with dial tone and busy detect, auto-answer, and audio monitoring through the computer's speaker. The PC1200B operates at 300 or 1200 bps, full duplex, and can perform an automatic self-test and receiver alignment at power-on. It can be put into analog or digital loopback modes. The modem requires a single expansion slot.



Crosstalk XVI is an intelligent terminal and file-transfer program. It uses the PC1200B's features to accomplish auto-dial, automatic log-on, auto-answer, and disk-to-disk data transfers. It stores as many as 40 separate log-on passwords and IDs, which enables you to reach utilities or mainframes with a single keystroke. Stop bits, parity, data rates, and duplex operations are under its control, and extensive error-checking and retransmission are included. It provides the means for sending captured data to a printer, buffer, or floppy disk. Crosstalk also displays the transmission time for each file.

For additional information, contact Novation Inc., 20409 Prairie St., Chatsworth, CA 91311, (213) 996-5060.

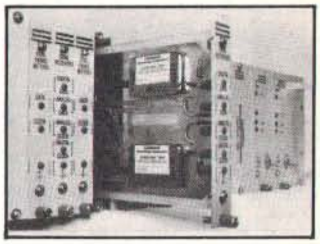
Circle 576 on inquiry card.

Software Links Incompatible Computers

U.S. Digital's Copylink program provides the means for the high-speed transfer of text and program code between dissimilar computers and DOSes. Copylink also provides access to public database services, Telex and TWX capabilities, and emulation of both smart and dumb terminals. Its error-detection code supports binary file transfers, and its CP/M error recovery technique, with DOS extensions, prevents the loss of data by unintentional exiting from the program or by disk overflow during file transfers. An audible prompt signals an error condition. Standard features include the ability to receive more than one disk of data, modem data rates up to 1200 bps, single-keystroke operation of functions, auto-answer, autoredial, automatic configuration of smart modems, full- and half-duplex transmission, display of previous file transfers, display of control characters, transmitter control for amateur radio transmission, a hard-copy option, and such user-defined parameters as originate/answer mode, parity, number of data and stop bits, and end-of-line sequence.

Copylink supports local data and program transfers between computers using 8- and 5¼-inch floppy-disk formats and machines running CP/M and MS-DOS. Its documentation includes a user's manual and **The Complete Handbook of Personal Computer Communications**. The suggested retail price is $99. User and dealer information is available from U.S. Digital Corp., 5899-D Southeast International Way, Milwaukee, OR 97222, (503) 654-0668.

Circle 573 on inquiry card.



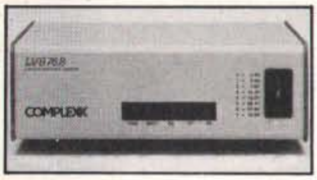
Secure Networks Safeguard Communications

Complete computer networks that are said to be virtually untappable are produced by Codenell Technology Corporation. The Codebeam line-of-sight optical communications system, the Codenet fiber-optic Ethernet local-area network, and the Codelink fiber-optic computer network transmit signals either through thin fiber-optic cables or by means of light beams. The Codenet-2020 Transceiver is compatible with Ethernet interface equipment through a 15-pin transceiver cable. It works with the Codestar passive star coupler to create a fiber-optic Ethernet network. This system enables the computer network to be removed from telephone lines, improving security and reducing operating costs.

For interbuilding networking, the Codebeam-

20 line-of-sight system can link networks without cables or telephone connections over distances of up to 2 kilometers. Large multisite computer networks can be implemented with the combination of the Codenet, Codelink, and Codebeam. For technical specifications, possible configurations, and purchasing information, contact Codenell Technology Corp., 1086 North Broadway, Yonkers, NY 10701, (914) 965-6300.

Circle 570 on inquiry card.

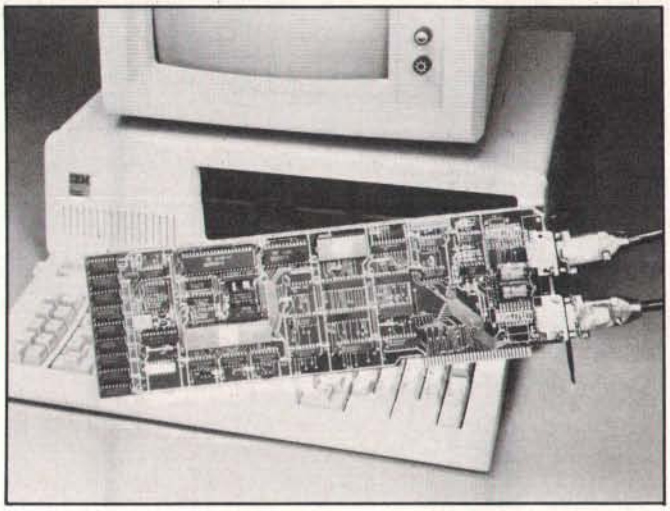


Modem Can Transmit at 76,800 bps

The LVS 76.8 limited-distance modem from Complexx Systems can send data 16,250 feet (5000 meters) on 22-gauge wire at 76,800 bps, and even greater distances can be achieved by transmitting at slower speeds or on heavier-gauge wire. The LVS has a front-cover thumbwheel that lets you select from eight synchronous speeds ranging from 2400 to 76,800 bps and LED indicators for power, data transmit, data receive, carrier detect, and testing. It can operate in point-to-point, multidrop polled, half-duplex two-wire, and full-duplex four-wire modes. The LVS is equipped with a Bell 43401-compatible switch. Additionally, the LVS is programmed to provide local and remote loopback.

Complexx Systems offers the LVS 76.8 with either an EIA RS-232C digital interface or with a V.35 interface. The retail price for the RS-232C model is $650, and the V.35 version is $725. For more information, contact Complexx Systems Inc., 4930 Research Dr., Huntsville, AL 35805, (205) 830-4310.

Circle 574 on inquiry card.



254 IBM PCs Linked with Percomnet

A user-installable local-area network, Percom Data Corporation's Percomnet interface for the IBM Personal Computer can link up to 254 nodes per network. Called the PN-IBM, this network interface plugs into the host computer and then is linked to the network through a data cable interface. At the heart of the PN-IBM is Western Digital's WD2840 network control processor. The WD2840 is designed to handle major communications tasks as they relate to the network token-access protocol, including network initialization, addressing, data transmission, acknowledgments, and diagnostics. Global addressing and dynamically alterable station priority are supported. Other key features include NBS data encryption for data security, signal regeneration at each node in order to maintain high signal-to-noise ratios, and a built-in 64K-byte FIFO buffer to speed data transmissions. PN-IBM supports simultaneous voice and data transmissions and is available with MS-DOS-, CP/M-, or Unix-compatible software.

Percomnet interface adapters will soon be announced for S-100, Multibus, and STD bus computers. Technical specifications are available from Percom Data Corp., 11220 Page Mill Rd., Dallas, TX 75243, (214) 340-5800.

Circle 571 on inquiry card.

Network Interface Unit for IBM and TI Computers

Ungermann-Bass has announced an intelligent Ethernet-compatible network interface unit (NIU) that allows IBM PC and Texas Instruments Professional Computers to share information and resources and integrate with large mainframes using IBM SNA protocols.

An extension of the company's Net/One general-purpose local-area network, the Net/One Personal Connection is based on the Personal NIU, a plug-in board with on-board intelligence to handle all communications. PCs configured with these NIUs can run any application programs under MS-DOS without modification. Applications can be shared across the network. Also featured are XNS protocols, and support for Ethernet and thin coaxial cabling. Net/One uses SNA gateways that let users access mainframe-based application programs. (SNA gateways are computers running software that permits them to emulate IBM 3274 controllers or 3278 terminals and 3287 printers.)

The Personal NIU costs $850, which includes MS-DOS networking commands. Quantity discounts are available. Print and disk-sharing software packages on 5¼-inch floppy disks are $500 per server. For complete details, contact Ungermann-Bass Inc., 2560 Mission College Blvd., Santa Clara, CA 95050, (408) 496-0111.

Circle 575 on inquiry card.

What's New?

On-line Brokerage

C. D. Anderson & Company, a San Francisco-based brokerage house, has announced that the Desk Top Broker financial service is on line. The Desk Top Broker lets you make transactions, maintain portfolios, see current stock prices, and check such data as change from previous close through your personal computer 24 hours a day, seven days a week. A unique feature of this service is an electronic-mail facility that enables you to make requests, such as transferring securities between cash and margin accounts, and notifies you that your orders have been carried out. A Stock Watch mode will track various aspects of up to 18 selected stocks, sound an alarm if a price changes, and alert you when a stock falls or rises above preset buy-and-sell limits. Additionally, you can maintain three separate portfolios, keep up-to-date tax records that reflect trade transactions, and attach conditions to buy orders. All the information stored in the Desk Top Broker can be transferred to a spreadsheet program for analysis and chart production. Double password security ensures data integrity.

Users of the Desk Top Broker are billed with a one-time charge of $300, which includes required software and registration fees. On-line connection fees range from $0.40 per minute during business hours to $0.10 per minute nighttime and weekends. Transaction charges are levied. Costs associated with the Desk Top Broker are said to be generally tax deductible. The system works with modem-equipped Apple and IBM Personal Computers. Inquire about its availability for other systems. Further details can be obtained from C. D. Anderson & Co., Suite 440, 300 Montgomery St., San Francisco, CA 94104, (415) 433-2120.

Circle 577 on inquiry card.

Low-cost Modem Uses TI Chip

The Micromint's ECM-103 build-it-yourself 300-bps modem is based on Texas Instruments' NMOS-technology TMS99532 FSK modem chip. The TMS99532 features all the necessary modulation, demodulation, and circuitry required for a full-duplex serial asynchronous communications link and eliminates many discrete components, reducing size and improving reliability. The ECM-103 is completely crystal-controlled and is suitable for acoustic or direct telephone-line connection through an FCC-registered data-access arrangement. Connection to data terminal equipment is EIA-standard RS-232C connector. No calibrations or adjustments are required, and it does not use external filtering or frequency set-point components.

The ECM-103 comes complete with all components, a printed-circuit board, RS-232C and power connectors, and an assembly manual. It costs $60 and is available directly from the Micromint Inc., 561 Willow Ave., Cedarhurst, NY 11516, (516) 374-6793; or (800) 645-3479 (orders only).

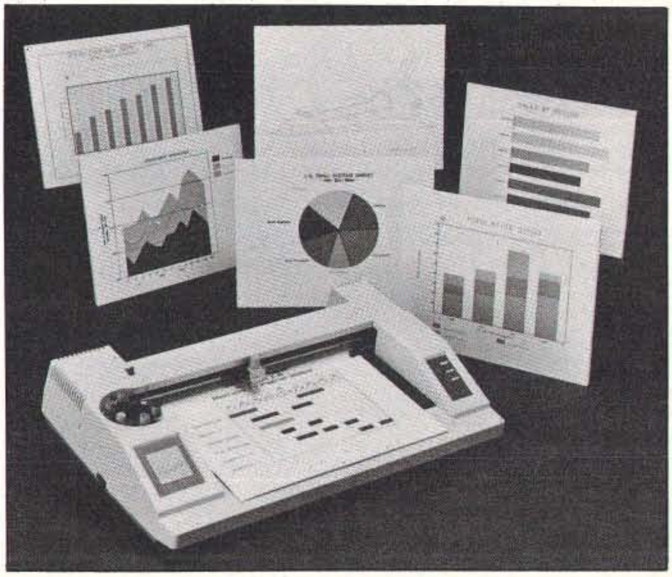
Circle 579 on inquiry card.

Source Subscription Free with Modem

Apple users will receive a permanent subscription to The Source database service free of charge with the purchase of the Networker modem from Zoom Telephonics. The Networker, a single-slot 300-bps modem, combines Apple communications circuitry and modem functions on a single card with direct low-noise modular-telephone connections. It works with Apple II, II Plus, and IIe computers. A floppy disk containing communications software is included in the Networker's $129 price tag. For the name of your nearest Networker dealer, contact Zoom Telephonics Inc., 207 South St., Boston, MA 02111, (617) 423-1072.

Circle 578 on inquiry card.

PRINTERS



Six-color Plotter Plots Graphs at 14 IPS

A fully automated six-pen plotter, the Sweet-P Model 600 Six-Shooter is produced by Enter Computer. Standard features include a 14-ips plotting speed, 3g acceleration, RS-232C and parallel interfaces, 19 character sets, self-test, and a 2K-byte buffer. Its six pens, housed in a rotating carousel, are automatically capped after use. Normally, the Six-Shooter plots with fiber-tip pens, but when necessary it can use a ballpoint or, for CAD applications, radiograph-type pens. It can draw on both 8½- by 11-inch and 11- by 17-inch paper, and it can create overhead transparencies. Operating features include pause and pen-selection keys and bar, pie, and polygon fill.

The Six-Shooter senses whether it's connected to a serial or parallel port and automatically switches from one to the other. In the serial mode, it can be used as a shared resource. You can place it between a computer and printer or between a terminal and printer and, operating in its eavesdrop mode, program it to perform only those tasks you want. All graphics software that supports the single-pen Sweet-P Model 100 will work with the Six-Shooter. It operates with Enter Computer's SPGL graphics language and is compatible with Hewlett-Packard's HPGL graphics language. It works with Apple and IBM computers, their compatibles, and CP/M-based systems.

Buffer expansion of up to 8K bytes and a choice of pens in 12 colors are options. The retail price for the Sweet-P Model 600 Six-Shooter is $1095, including pens, paper, and operating manual. For more details, contact Enter Computer Inc., 6867 Nancy Ridge Dr., San Diego, CA 92121, (619) 450-0601.

Circle 580 on inquiry card.

Printer Mechanism Targeted at OEMs

An 80-column printing mechanism targeted at the OEM and system-integrator market has been announced by Hi-G Printers Corporation. The Model 9/80 ME printer mechanism features independent horizontal- and vertical-axis control for accurate dot placement in multipass printing and graphics output. Using a standard 9- by 7-dot array and off-the-shelf ribbons, the 9/80 ME will print at speeds as high as 200 cps. The unit has front, bottom, and rear paper entrances and top and bottom exits. It has provisions for internal roll paper and for mounting a sheet feeder for 8½- by 11-inch cut paper or envelopes. The 9/80 ME accepts externally housed, fan-folded, sprocket-driven paper and can handle standard paper stock, carbon or carbonless forms, and gummed or pressure-sensitive labels. It's furnished with a nine-wire printhead and a standard tractor drive. Its physical specifications are 5⅞ inches high by 20¾ inches wide by 16¼ inches deep. It weighs 17 pounds. All critical components, such as the printhead, ribbon motor, and carriage subassembly, are manufactured by Hi-G Printers.

The 9/80 is also available in a reverse tractor, demand-document version featuring a dedicated paper chute. An 18-wire printhead can be furnished. Evaluation quantities cost $299 each. Delivery is from stock. For additional information, contact Hi-G Printers Corp., 96 West Dudleytown Rd., Bloomfield, CT 06002, (203) 242-3048.

Circle 605 on inquiry card.

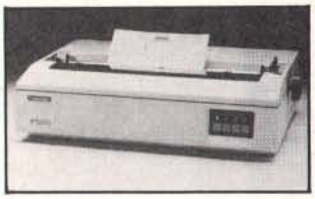
Portable Printer Weighs In at 16 Pounds

Sprinter is an 80-column, 160-cps portable printer from Micro Peripherals Inc. This 16-pound dot-matrix printer features an IBM-compatible parallel port, high-speed skipover, five character sets, built-in friction- and tractor-feed mechanisms, user-programmable character sets, a 4K-byte buffer, and graphics capabilities. Its base price is $795.

The Sprinter can be ordered with a unique option called the Softswitch. Softswitch is a keypad that provides a simple way to change the printer's operating functions. It offers control over such functions as horizontal tabbing, alternate character-set selection, form length, linefeed on carriage return, and vertical line density. A battery-backed RAM that retains user-set functions when the power is off completes the Softswitch option.

Additional options for the Sprinter include up to 68K (34 pages) of data buffers and IEEE-488 and RS-232C interfaces. A carrying case will be offered after the first of the year. The base price is $795. For full particulars, contact Micro Peripherals Inc., 4426 South Century Dr., Salt Lake City, UT 84107, (800) 821-8848; in Utah, (801) 263-3081.

Circle 582 on inquiry card.



P1350 Works with Variety of Micros

Toshiba's P1350 desktop dot-matrix printer will now work with microcomputers from such manufacturers as Apple, DEC, and IBM. The P1350 produces letter-quality correspondence, high-speed drafts, and dot-addressable graphics with a 24-pin printhead that uses fine-wire 8-mil pins to overlap dots in a single pass. When in the letter-quality mode, this printer operates at 100 cps. Draft work runs at 192 cps, and graphics are printed at a density of 180 by 180 dots per inch.

The P1350 is a 132-column printer that yields an original plus three copies on letter-sheet or continuous-form paper that can be as wide as 15 inches or as narrow as 5 nches. Qume Sprint 5 emulation, an enhanced Courier font, and software-selectable multiple fonts, pitches, and line spacing are standard. For feeding paper, the P1350 can be equipped with a friction roller or with optional pin-feed tractor or sheet feeders. The standard interface is Centronics parallel. An RS-232C serial interface is available as an option at no extra charge.

The P1350 retails for $2195. For more information, contact Toshiba America Inc., Information Systems Division, 2441 Michelle Dr., Tustin, CA 92680, (714) 730-5000.

Circle 677 on inquiry card.

Graph Option for Plotter

Yokogawa Corporation of America has announced the availability of a PROM option for its PL-1000 four-color plotter. The PROM provides the plotter with the ability to generate pie, line, and bar graphs without external programming. In addition, it provides cross-hatching and lettering/labeling capabilities. The PL-1000 has a standard RS-232C interface and plots on paper or foil as large as 11 by 15 inches.

The PROM option costs $215. For current owners of the plotter, the option is available as a factory-installed retro fit. For more details, call or write Yokogawa Corp. of America, 2 Dart Rd., Shenandoah, GA 30265, (404) 253-7000.

Circle 678 on inquiry card.

Low-cost Impact Printer

The Impact Printer works with Fidelity Electronics' Desk Companion and the Commodore VIC-20 and 64. This dot-matrix printer offers 24, 32, or 40 columns of uppercase and owercase 5- by 7-dot-matrix characters. Standard eatures include 30-cps operation, dot-addressable graphics, reverse character mode, and two character ets. A power-on LED and manual controls for power on and off and paper feed are provided. The mean time between failures is approximately 50,000 lines. The Impact Printer measures 4 inches wide by 4½ inches long by 2 inches high. Standard 2¼-inch adding-machine roll paper is required.

The suggested retail price is $129.95. For more details, contact Fidelity Electronics Ltd., 8800 Northwest 36th St., Miami, FL 33178, (305) 888-1000.

Circle 681 on inquiry card.

PERIPHERALS

Image Processing Camera Sees for Micros

Datacopy's Model 610 electronic digitizing camera lets you enter photos, documents, or three-dimensional objects into your office's desktop computer without the use of a keyboard. The 610 captures an image through a standard 35-mm camera lens. Inside the unit, a linear array of 1728 solid-state photosensors is physically scanned across the image, translating it into computer-readable digital code. Image information is then organized into a matrix of 4.9 million cells, called pixels (picture elements). A digital converter changes the information into the digital equivalent of the optical image on a pixel-by-pixel basis. The image represented in two dimensions with shades of gray, can now be displayed, printed out, or stored in the computer's memory.

The 610 requires little illumination, even when capturing microfiche, drawings, or printed text. A complementary product, the Model 110 Image Processing Interface, provides image-capture software and the ability to work with the IBM Personal Computer. For systems integrators and software houses using the IBM, the Model 90 Integrated System is offered. This system is made up of the 610 camera, the 110 interface, and such accessories as the camera power supply and cables.

The Model 610 electronic digitizing camera has a $7850 end-user price. The Model 110 and Model 90 list for $795 and $9945, respectively. Address inquiries to Datacopy Corp., 1070 East Meadow Circle, Palo Alto, CA 94303, (415) 493-3420.

Circle 592 on inquiry card.

Joystick for Apples and IBMs

The Data Spec line of joysticks works with Apple II, IIe, and IBM Personal Computers. One model in the line, the Model IB-XY-23, is plug-compatible with the IBM PC. It's designed to meet the demands of the commercial/industrial market. Standard features include linear potentiometers, a metal enclosure for maximum shielding and stability, dual X-Y fine centering, positive feel push buttons, and a four-foot cord. The suggested retail price is $69.95. Contact Ora Electronics, 18215 Parthenia St., Northridge, CA 91325, (213) 701-5848.

Circle 587 on inquiry card.

Multifunction A/D I/O Subsystems

The PCDAX Subsystem provides multifunction data-acquisition and control capabilities for a variety of computers. A minimum configuration comprises a PCDAX enclosure with interface to a host computer and LDT2801 series analog and digital I/O boards. The LDT2801 board includes 12- or 16-bit A/D converter for 16 single-end or eight differential analog input channels, software-selectable gains of 1, 2, 4, and 8 to accommodate a range of signal levels, analog outputs, digital I/O, direct memory access, and a programmable clock. Sampling rates can be as high as 22,000 samples per second. The LDT2801 boards are built around an on-board microprocessor that acts as an interface to the computer, controls all analog and digital operations, and facilitates program control by the host computer. To initiate repetitive conversion events, the LDT2801 has an internal system clock that's programmable for periods ranging from 5 microseconds to 0.1638 seconds, in 2.5-microsecond increments. Other boards provide periods of 2.5 microseconds to 0.0819 seconds with 1.25-microsecond increments. All boards provide for an external clock, which enables synchronization of multiple A/D or D/A conversions with a frequency source. Two LDT2801 boards can be installed in a single PCDAX. They can be programmed in any language resident in the host computer.

Two screw terminal/signal conditioning panels and software subroutine packages are available as options. For data sheets and complete price information, contact Data Translation, 100 Locke Dr., Marlboro, MA 01752, (617) 481-3700.

Circle 593 on inquiry card.

Trio Enhances IBM PC

PC Ware has introduced three products for the IBM PC and PC XT: a parallel printer adapter, a serial communications adapter, and a 256K-byte RAM board. The parallel printer adapter, which can serve as a general-purpose I/O port, offers 12 buffered TTL latched outputs, five buffered TTL inputs, software-controlled interrupts, and full software programmability. It costs $89.95.

The software-programmable asynchronous RS-232C serial communications adapter supports full- and half-duplex operations. Its crystal-controlled data rates are software-programmable from 50 to 19,200 bps and include 134.5 bps. Among its other features are a simple DCE/DTE configuration header; a programmable control register; double-buffered data; parity, overrun, and framing error checks; hardware selection of I/O mapping; support for such modem controls as CTS, RTS, DTR, RI, and carrier detect; four handshake signals; line-break generation and detection; and fully prioritized interrupts to control transmit, receive, error, line status, and data-set interrupts. The suggested price is $94.95.

The RAM board offers DIP-switched addresses, selectable on any 64K-byte boundary. A bare board costs $189.95. With RAM chips, it ranges from $229.95 (64K bytes) to $349.95 (256K bytes).

For full details on these products, call or write PC

Ware Inc., 4883 Tonino Dr., San Jose, CA 95136, (408) 978-8626.

Circle 600 on inquiry card.

Color Graphics Adapter for Eagles

A single card providing the Eagle PC, Eagle 1600 Series, and the IBM PC with a color display and graphics capabilities is now being marketed by Eagle Computer. This color graphics adapter, which can operate in color or monochrome, features two basic modes of operation: alphanumeric and all-points-addressable graphics; additional operating modes are available from within these formats. A medium resolution of 320 by 200 pixels and 16 foreground and 8 background colors are offered in the color mode. In the monochrome mode, a high-resolution display of 640 by 200 pixels is achievable. Also featured in the monochrome mode are reverse video, blinking character, and highlighting. Character blinking is offered in the color mode.

The color graphics adapter will link the Eagle to a display through a composite video port, a direct-drive RGB port, or an interface for driving a user-supplied RF modulator. The adapter costs $295. For more information, contact Eagle Computer Inc., 983 University Ave., Los Gatos, CA 95030, (408) 395-5005.

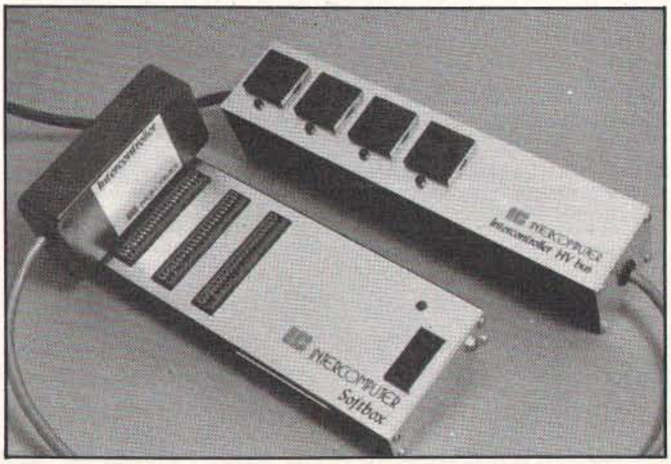
Circle 599 on inquiry card.

Bar-Code Reader Supports 39 and Interleave 205 Codes

Percon's E-Z-Reader bar-code reader supports 39 and interleave 205 industrial bar codes. It provides operator feedback and can read dot-matrix and medium-density printed labels. Operator feedback is provided by a beeper, two host-controlled LED status indicators, and a low-frequency tone. Communications is standard RS-232C, eavesdrop, or with a stand-alone computer. The digital wand is produced by Hewlett-Packard.

The E-Z-Reader costs $395. An operating and installation manual is available for $20. Dealer and OEM inquiries are invited. Contact Percon, POB 1352, Eugene, OR 97440, (503) 688-3374.

Circle 595 on inquiry card.



Expansion Box and Control Device Introduced

Intercomputer has introduced two interrelated products that are compatible with Timex/Sinclair, Commodore 64 and VIC-20, and Texas Instruments 99/4A computers: Intercontroller and the Softbox. Intercontroller is a programmable control unit that lets you control electrical devices with your computer. It has four standard electrical outlets that you can program using a few simple BASIC commands. The Softbox expansion box has four software-selectable slots that are used with program cartridges and the Intercontroller. It also contains an extra peripheral port.

A nonvolatile memory cartridge and temperature, sound, and light sensors will soon be available for the Softbox, which costs $59.95. A required connector cable is available for $17.95. Intercontroller is $99.95. For dealer information or to place an order, contact Intercomputer Inc., 358 Chestnut Hill Ave., Boston, MA 02146, (617) 738-5310.

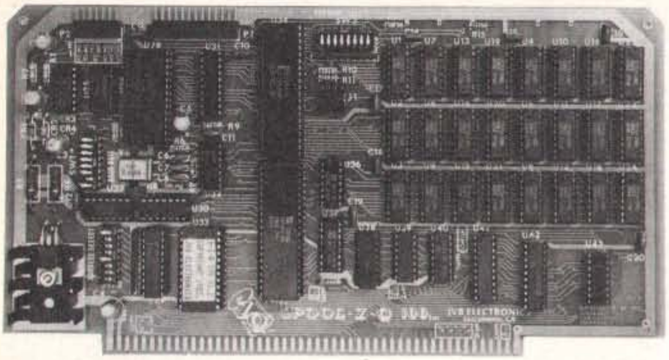
Circle 591 on inquiry card.

Autocrat Provides Remote Control over AC Lines

The Autocrat is a powerline communications product from Bi-Comm Systems. This microprocessor-based controller is used to remotely control electrical devices through existing AC wiring. It plugs directly into a standard wall socket, where it transmits and receives signals over the AC lines. Up to 256 Leviton CCS accessories and BSR X-10 devices can be controlled by Autocrat. A battery-backed CMOS clock/calendar, a firmware operating system in EPROM, memory from data and applications program storage, and self-diagnostics are included with Autocrat. It can operate as a stand-alone unit, as a computer-controlled interface, or under telephone modem control.

Autocrat is compatible with computers, terminals, and energy-management controllers equipped with an RS-232C port. The manufacturer will develop custom applications software by contract and support customers developing their own software. Autocrat costs $485 and is available factory-direct from Bi-Comm Systems, 10 Yorktown Court, St. Paul, MN 55117, (612) 481-0775.

Circle 590 on inquiry card.

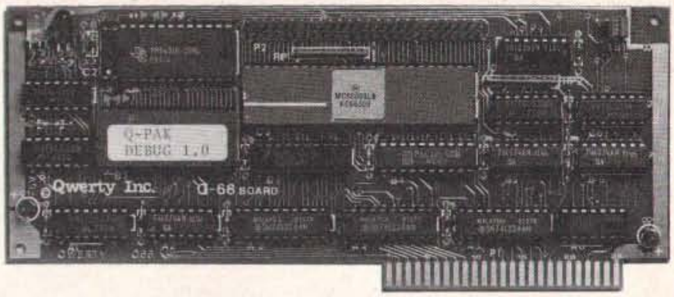


Buffer Can Handle 256K

An S-100-compatible printer buffer capable of handling up to 256K bytes of memory, the Spool-Z-Q 100 works with both serial and Centronics-type parallel printers. Its on-board microprocessor handles all protocols and handshaking, and an open socket is available for a switch panel that lets you control Copy, Clear, Buffer, and self-test functions. The Spool-Z-Q has Normal and Pause-on-Form-Feed modes that provide for both normal buffered printing and a pause for, say, inserting another sheet of paper. Several protocols are supported, including Xon/Xoff, ETX/ACK, ENQ/ACK, and DTR. For the serial interface, Spool-Z-Q provides switch-selectable data rates, parity, and word length. The data rates are 150, 300, 600, 1200, 2400, 4800, 9600, and 19,200 bps.

The Spool-Z-Q, which uses 4164-type chips, is fully socketed for 256K bytes of memory. Memory sizes available are 32K, 64K, 128K, and 256K bytes. Prices range from $319 for a 32K-byte buffer to $529 for the fully loaded version. For more information, contact JVB Electronics, Suite 10A, 1601 Fulton Ave., Sacramento, CA 95825, (916) 483-0709.

Circle 594 on inquiry card.



Add-on Package Turns Apple into 68000 Development System

The Apple II can be converted into a 68000 assembly-language development system with the Qpak-68 board and software package from Qwerty Inc. Qpak-68 comprises a plug-in board to run 68000 programs, an editor/assembler to create 68000 source code, a debugger, and support documentation. The board plugs directly into the Apple and uses the 68008 microprocessor, which is an 8-bit software-compatible version of the 68000. The 68008 is driven by the Apple's clock, which permits it to run parallel with the 6502 in the Apple. The processor can be started, stopped, or interrupted at any time from the Apple.

The Qpak board is able to run directly out of the Apple's memory. It shares the Apple's 64K-byte memory space and can access the same memory and peripherals as the Apple's 6502 processor, including the high-resolution display. It comes with 8K bytes of local EPROM and 2K bytes of RAM, expandable to 32K and 8K bytes, respectively. The debugger, resident in EPROM, displays five screen windows to monitor or change registers or memory and to set breakpoints. It includes instruction single-step and disassembly. The source-code development package, which comes on an Apple-compatible disk, can assemble 68000 programs with object code larger than 8K bytes directly from RAM. Larger programs can be assembled from Apple disks.

The complete Qpak-68 package costs $695. It's available directly from Qwerty Inc., Suite 600, Chesapeake Dr., San Diego, CA 92123, (619) 569-5283.

Circle 589 on inquiry card.

Scanner Recognizes Characters and Images

When connected to an RS-232C port, Symeon & H. Corporation's Cosmos CAX-21 image-scanning system transfers images and printed characters to a personal computer. Salient specifications include a scanning width of 3.3 mm and a 0.16- by 0.16-mm per dot scanning rate. Power requirements are 9 to 12 volts DC or 110, 115, 220, or 240 volts AC at 50 or 60 Hz, with an AC adapter. Accessories include software, a scale, RS-232C interface cable, power adapter, and a base plate. Presently, the software for CAX-21 works with the Apple II; however, the programs are being converted for other computers.

Cosmos CAX-21 features two software-based scanning modes: List Reader and Image Scanner. Program listings, documents, and other characters produced by serial dot-matrix printers can be read and transmitted to your computer with List Reader. If the transmitted characters match a user-created standard pattern, they are displayed on your video monitor. Recognized characters can be stored on disk for later printout. The Image Scanner handles printed or hand-drawn illustrations, maps, and other images. Image editing is possible through the keyboard. Hard copies can be produced. Its maximum image size is 180 by 180 mm.

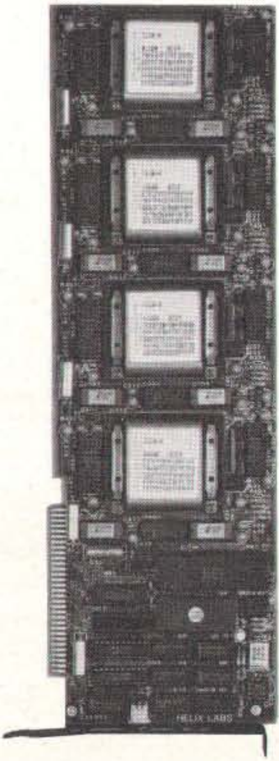
For more information, contact Symeon & H. Corp., 5676 Francis Ave., Chino, CA 91710, (714) 627-9887.

Circle 596 on inquiry card.

Half-Megabyte Bubble Memory for IBM

A half-megabyte bubble-memory board designed to emulate a mini-Winchester disk drive inside the IBM Personal Computer is available from Helix Laboratories. The PC Bubble Board is said to respond to fixed-disk commands under most operating systems, including MS-DOS 2.0, Softech Pascal IV.13, and CP/M-86 for the IBM PC XT. Among the software features available to users are Restore, Backup, and partitioning to hold multiple operating systems. The solid-state PC Bubble has four 1-megabit Intel 7110 bubble memories, a 40-millisecond access time, and a data transfer rate of 400,000 bits per second.

The PC Bubble Board will also work with such computers as the Corona and Compaq. It costs $1495. Complete specifications are available from Helix Laboratories Inc., Suite 106A, 16776 Bernardo Center Dr., San Diego, CA 92128, (619) 451-0270.



Circle 586 on inquiry card.

SYSTEMS

80186-based Systems Run Concurrent CP/M

Onyx Systems' 186 Series of 16-bit desktop computers is based on Intel's 80186 processor and is capable of running Concurrent CP/M-86. A basic configuration has a display terminal, 256K bytes of RAM, and 1 megabyte of floppy-disk storage. The 14-inch nonglare blue- or green-phosphor display features the 256-character ASCII set and business graphics capabilities. The terminal tilts and swivels and has a 104-key intelligent keyboard. A numeric keypad, cursor-control pad, 28 function keys, and a standard typewriter format are featured.

Expansion capabilities provided include six RS-232C serial ports, an 8-bit Centronics-compatible parallel port, and two disk/tape ports. Additional expansion options include up to 512K bytes of RAM, a cabinet to house drives and backup tape cartridges, 1 megabyte of floppy-disk storage, and 7-, 14-, or 21-megabyte 5¼-inch Winchester hard-disk drives. The Onyx 186 Series is available with Concurrent CP/M-86, Oasis-16, or MBOS/BB3 for multiple users and MS-DOS for single users.

Prices for complete workstations begin at $4495. For complete details, contact Onyx Systems Inc., 25 East Trimble Rd., San Jose, CA 95131, (408) 946-6330.

Circle 609 on inquiry card.

PC Plus and PC Deluxe Run MS-DOS

The PC Plus and the PC Deluxe from Scottsdale Systems run MS-DOS programs as well as a number of PC-DOS programs. The PC Plus is an 8088-based machine that's outfitted with a 160K-byte floppy-disk drive, 256K bytes of RAM, a printer spooler, a parallel printer port, and color/monochrome video output. System software includes Ramdisk, MS-DOS, Wordstar, Calcstar, Easywriter, and Sanyo Color BASIC. It costs $999.

In addition to the software supplied with PC Plus, PC Deluxe comes with Easy Planner, Easy Filer, Easy Mailer, and Easy Speller. It also has two floppy-disk drives. Its price is $1399. For more information, contact Scottsdale Systems Ltd., 617 North Scottsdale Rd. #B, Scottsdale, AZ 85257, (602) 941-5856.

Circle 604 on inquiry card.

IBM PCjr Available in Two Versions

A 16-bit 8088-based computer, the IBM PCjr is available in two versions: a $699 system unit and a $1269 slim-line floppy-disk drive model. The basic PCjr features a cordless keyboard that transmits keystrokes to the main unit by infrared signals at distances of up to 20 feet. Each of its 62 keys can be programmed for custom applications, and its function keys are color coded.

Standard equipment includes 64K bytes of ROM, two cartridge slots, 64K bytes of RAM, a serial port, cassette level BASIC, sound and graphics subsystems, and interfaces for a cassette, two joysticks, keyboard, modem, floppy disk, light pen, direct video, composite video, and television. To help new computer users get started, the PCjr comes with a ROM-based program that uses graphics, colors, and sound to highlight the keyboard.

The PCjr can display 40 columns of text on a television, composite display, or a direct-drive color monitor with the addition of an optional adapter or connector. The enhanced PCjr has 80-column display capabilities and comes with 128K bytes of RAM, 360K bytes of floppy-disk storage, and a pair of tutorial disks. It has 80-column display capabilities. Both versions are supplied with an operator manual and a BASIC handbook.

Options include a modem and parallel printer attachment. The IBM PCjr is available at IBM Personal Computer dealers. IBM Entry Systems Division, POB 2989, Delray Beach, FL 33444.

Circle 601 on inquiry card.

2000 Uses 80186 Chip, Two DOSes

A 16-bit Intel 80186-based computer, the System 2000 was recently unveiled by Monroe Systems for Business. Supplied with two DOSes, MS-DOS and CP/M-86 DPX, and GW BASIC, the 2000 will support such languages as Pascal, FORTRAN, C, and COBOL. Single or dual 5¼-inch floppy-disk drives, 128K or 256K bytes of RAM, a monitor, a parallel printer port, five expansion slots, and a clock/calendar are standard. Mass-storage capacities are 720K bytes per disk under MS-DOS or 640K bytes under CP/M-86. The 2000's twin RS-232C serial ports offer programmable data rates ranging from 75 to 19,200 bps and are offered with asynchronous or asynchronous and synchronous capabilities. The low-profile, detached keyboard that comes with the System 2000 has separate cursor and numeric keypads, four application-defined program keys, and 10 user-defined function keys.

The 12-inch amber monochrome monitor is backed by 128K bytes of dedicated RAM. The antiglare screen can display 2000 characters in an 80-column by 25-line format while offering 640- by 400-pixel bit-mapped graphics capabilities. Its 256 IBM-compatible character set can be produced with such attributes as reverse, underline, high-intensity, blinking, and nondisplay black or white. The tilt and swivel pedestal can also accommodate a 14-inch, 16-color RGB monitor.

Options include a Z80A coprocessor, RAM expansion up to 896K bytes, up to three RS-232C interface boards, internal or external hard-disk drives, and letter-quality and dot-matrix printers. Word-processing, spreadsheet, database-management, and graphics packages are among the programs available. Prices begin at $3695. For additional information, contact Monroe Systems for Business, The American Rd., Morris Plains, NJ 07950, (201) 993-2000.

Circle 607 on inquiry card.

What's New?

PC-Compatible Targeted at Professionals

The TS 1605 computer is targeted at business and professional users. Manufactured by Televideo Systems, this 16-bit computer is hardware- and software-compatible with the IBM PC. It comes equipped with dual half-height 5¼-inch floppy-disk drives, each of which accommodates 368.6K bytes of formatted data, a single RS-232C asynchronous port, and an IBM-style DB-25S parallel printer port. The TS 1605's 128K bytes of user memory can be expanded to 256K bytes. High-resolution 640- by 200-pixel graphics are possible on the unit's standard 14-inch green-phosphor display. The TS 1605 can be networked under CP/M-86. For more details, contact Televideo Systems Inc., 1170 Morse Ave., Sunnyvale, CA 94086, (408) 745-7760.

Circle 602 on inquiry card.

Low-cost 64K Computer

Video Technologies designed its Laser 3000 personal computer with two tiny gate-array chips that take the place of more than 200 integrated circuits at a fraction of the cost. The basic Laser has 64K bytes of RAM, 80-column display capabilities, a Centronics-type parallel printer port, and a four-channel programmable sound generator. Its graphics capabilities comprise three modes, one of which provides a six-color 560- by 192-pixel matrix. Other features include a 24K-byte ROM with Microsoft BASIC, eight user-definable function keys, a calculator numeric pad, and a switching power supply. The Laser 3000 is said to be able to run most Apple II software. Optional components will enable it to run CP/M software and provide 16-bit capabilities for running MS-DOS and CP/M-86.

Disk-drive units are available. The Laser 3000 costs $695. For more information, contact Video Technologies (U.S.A.) Inc., 2633 Greenleaf Ave., Elk Grove Village, IL 60007, (312) 640-1776.

Circle 603 on inquiry card.

Computer Serves Alone or in Network

The Lanier Business Processor 1000 works as a stand-alone unit or can be linked with other workstations in a Lanier Business System 5000 network. The 1000 can also be interfaced with office data-communications systems using IBM 3270 SNA and 3780 communications protocols or those with TTY-ASCII capabilities. Basic system hardware comprises dual 8- and 16-bit processors, 128K or 256K bytes of RAM, and half-height floppy-disk drives. It can be equipped with optional 5- or 10-megabyte Winchester hard-disk and floppy-disk drive configurations. Other options include a tilt-and-swivel base for operator comfort and graphics capabilities for generating business charts and graphs. The 1000 supports CP/M and MS-DOS in addition to Lanier's software.

The base price for the Processor 1000 is $2995, which includes installation and on-site training. It's available at more than 340 sales locations nationwide. For further information, contact Lanier Business Products Inc., 1700 Chantilly Dr. NE, Atlanta, GA 30324, (404) 329-8000.

Circle 608 on inquiry card.

PUBLICATIONS

CAD/CAM Directory Focuses on Specs

A directory of the computer-aided design and manufacturing hardware and software relying heavily on technical specifications, **The CAD/CAM Industry Directory** is available from Technical Database Corporation. This directory offers more than 100 listings detailing CAD/CAM systems, CAD video-display terminals, testing systems, plotters, programmable controllers, harsh environment CAM terminals, special communications software, industrial databases, systems houses, and consultants. Each product listing includes full specifications, price information, delivery time, length of warranty, European and Japanese marketing contacts, and vendor name, address, and telephone number.

The directory costs $35 domestic, $43 overseas. Bimonthly specification updates are available for $15 ($19 foreign). Contact Technical Database Corp., POB 720, Conroe, TX 77305, (409) 539-9688.

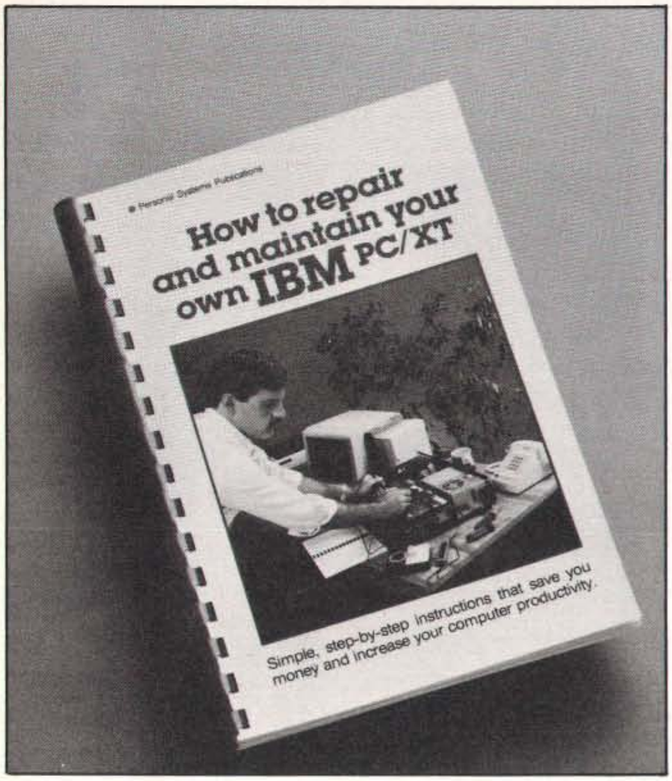
Circle 611 on inquiry card.

Research via Communication

Alfred Glossbrenner has written a buyer's and user's guide, **The Complete Handbook of Personal Computer Communications**, which details the time- and money-saving benefits of intercomputer communications. Tips in the book include descriptions of how your research is enhanced by access to Compuserve, Tradenet for swapping goods and services, three encyclopedic databases, telephone directories, a daily index of 2000 news stories, and a magazine index that can search 600,000 citations from more than 350 current periodicals. The paperback version is $14.95. Contact St. Martin's Press, 175 Fifth Ave., New York, NY 10010, (212) 674-5151.

Circle 617 on inquiry card.

What's New?


Personal Systems Publications
How to repair and maintain your own IBM PC/XT
Simple, step-by-step instructions that save you money and increase your computer productivity.

IBM PC XT Repair Manual

A 200-page IBM PC and PC XT repair manual written for both the experienced and nontechnical user has been released by Personal Systems Publications. **How to Repair and Maintain Your Own IBM PC/XT** offers step-by-step instructions, explains most probable hardware problems, and provides troubleshooting tips. The book aids the novice by showing him or her how to use a volt-ohmmeter and logic probe for troubleshooting testing.

How to Repair and Maintain Your Own IBM PC/XT costs $19.95. Order from Personal Systems Publications, POB 90754, Los Angeles, CA 90009.

Circle 610 on inquiry card.

Communicative Directory

A 26-page directory, **Personal Computers and User-Programmable Terminals**, contains details about 100 terminals that can communicate with 51 personal computers in a data-communications environment. All products covered connect to the communications network via an RS-232C serial interface, and all have software that supports interaction with the host processor. Different sections in the report relate to stand-alone or cluster environments, displays, data editing and formatting, operating systems, and programming languages. The report costs $29 and is available from Data Decisions, 20 Brace Rd., Cherry Hill, NJ 08034, (609) 429-7100.

Circle 618 on inquiry card.

The Naked Truth Behind the Computer

Computer trivia, anecdotes, world records, and lore are the subject of **The Naked Computer** by Jack B. Rochester and John Grantz. From this work you'll learn that the first computer bug was actually a moth that met its demise in a relay of the Mark I analyzer at Harvard and read about a computer that attempted to use water instead of electrons for switching circuits. Subtitled **The Layperson's Almanac of Computer Lore, Wizardry, Personalities, Memorabilia, World Records, Mind Blowers, and Tomfoolery**, this 335-page hardcover book costs $15.95. It's published by William Morrow & Co., 105 Madison Ave., New York, NY 10016, (212) 889-3050.

Circle 613 on inquiry card.

MS-DOS Explained

A thorough overview of Microsoft's popular MS-DOS operating system is provided in **How to Get Started with MS-DOS** by Carl Townsend. Written in a manner that helps beginners understand and use MS-DOS quickly and effectively, this book covers such topics as why computers require DOSes and how to use a word processor. Other areas covered include IBM hardware, files, records, disks, using commands and utilities, and backup and safety procedures for disks. A series of appendices containing MS-DOS tables and maps, error messages, MS-DOS and BASIC commands, and a glossary round off the book.

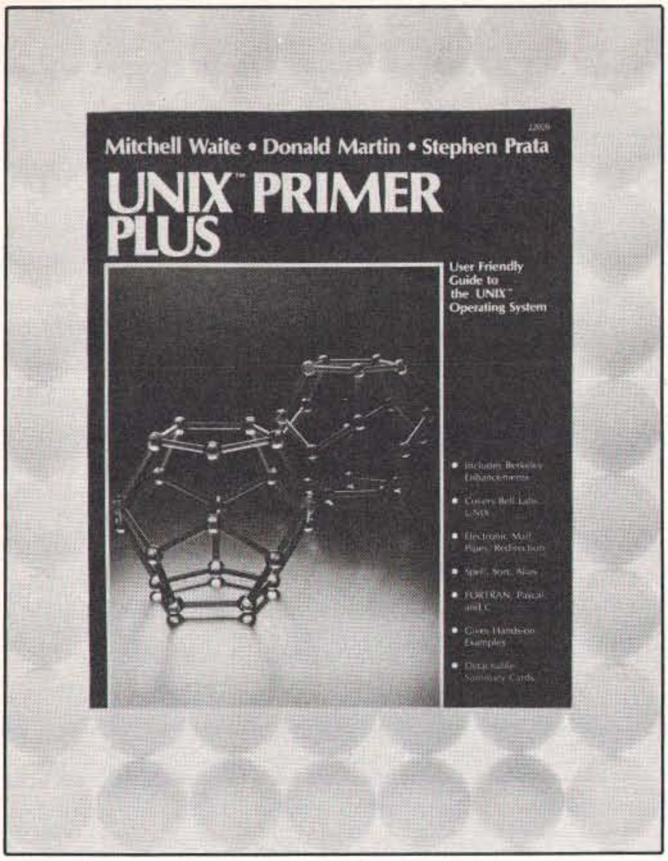
How to Get Started with MS-DOS is $13.95. It can be ordered directly from the Dilithium Press, Suite 151, 8285 Southwest Nimbus, Beaverton, OR 97005, (800) 547-1842; in Oregon, (503) 646-2713.

Circle 612 on inquiry card.

Computer Bulletin for Educators

The School Microcomputing Bulletin provides educators with information on the use of computers as effective teaching aids and administrative tools. **The Bulletin** has descriptions and evaluations of computer products as they performed in school settings and news on industry developments of interest to educators. Eight 8-page issues are produced during the school year. **The Bulletin** does not accept advertisements. For ordering information and a free sample copy, write to the Managing Editor, Learning Publications Inc., Department NR, POB 1326, Holmes Beach, FL 33509.

Circle 616 on inquiry card.


22009
Mitchell Waite • Donald Martin • Stephen Prata
UNIX™ PRIMER PLUS
User Friendly Guide to the UNIX™ Operating System
Includes Berkeley Enhancements
Covers Bell Labs UNIX
Electronic Mail, Pipes, Redirection
Spell, Sort, Alias
FORTRAN, Pascal and C
Gives Hands-on Examples
Detachable Summary Cards

Unix Guide Starts from Scratch

Mitchell Waite, Donald Martin, and Stephen Parta have teamed up to produce a start-from-scratch guide to Bell Laboratories' Unix operating system. **The Unix Primer Plus** is a 288-page tutorial and guide designed for anyone interested in learning about Unix. Anecdotes, analogies, and illustrations frame the presentations, and nontechnical introductory chapters explain fundamental Unix concepts and commands. Later in the book, detailed chapters describe advanced commands and features. Overviews and summaries supplement introductory materials to help comprehension.

The Unix Primer Plus comes in a loose-leaf binder so that readers can add pages of notes, supplement information, or customize the presentation to specific Unix installations. It costs $19.95. For more information, contact Howard W. Sams & Co. Inc., 4300 West 62nd St., Indianapolis, IN 46268, (317) 298-5400.

Circle 615 on inquiry card.

MISCELLANEOUS

Gang Programmer Has 32K of Buffer Memory

The Model 8204 is a self-contained gang programmer with 32K bytes of buffer memory. It offers selectable protocols for popular development systems, block-mode data transfer, selectable data rates, editing, checksum computation, and the ability to program up to eight EPROMs. This device can operate as a stand-alone unit or in conjunction with a computer. The Model 8204 programs such EPROMs as the Intel 2758 and 2732/A, the Texas Instruments TMS2508 and TMS2558, the National NMC2724, the Motorola MCM2816, and the Hitachi HN48016P. Operation features include verification during and after the program cycle, confirmation of the master's validity by the display of its checksum, and occupancy checks to ensure that the master is present and programmed, that at least one blank slave is present, and that all devices are properly registered. Failures are indicated visually and audibly. Operating voltage is 110/220 V AC ±15 percent at 50/60 Hz.

The Model 8204 Programmer costs $1295. It's available from Sherman Pirkle Inc., 3 Captain Parker Arms, Lexington, MA 02173, (617) 861-6688.

Circle 621 on inquiry card.

Standby Supply Powers 16-Bit Systems

Ladco Development's Model 250B standby power supply has a rating of 250 amperes at 115 V AC. It comes with a 10-ampere-hour maintenance-free battery, RFI line filtering, voltage surge suppression, over- and underline voltage protection, a battery charger with overcharge and short-circuit protection, a battery condition meter, visible and audible failure indication, and a frequency-controlled, square-wave-output 60-cycle inverter. It can power 16-bit computers with hard disks as well as video terminals. The battery can operate for 10 minutes. The Model 250B monitors line voltage for factory-set limits of 103 to 130 volts and automatically switches to standby when deviation occurs.

The Model 250B costs $545. Quantity discounts are available. For more information, contact Ladco Development Co. Inc., POB 464, Olean, NY 14760, (716) 372-0168.

Circle 619 on inquiry card.

Videotaped Short Course on FORTRAN

A videotaped short course on FORTRAN is available from Colorado State University. This introductory course covers FORTRAN in 10 half-hour lectures. Each lecture begins with a discussion of the previous assignment. Topics such as batch use and interactive FORTRAN are covered step by step in this presentation. Leasing and purchasing information is available from W. L. Somervell Jr., Engineering Renewal and Growth Program, Engineering Research Center, Colorado State University, Fort Collins, CO 80523, (800) 525-4950; in Colorado, (303) 491-8417.■

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Circle 69 on inquiry card.

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CORVUS	disk drives	CALL

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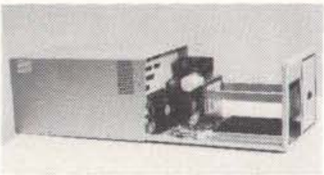
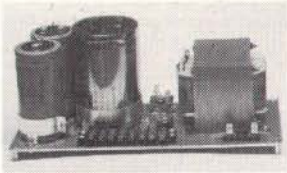


No. 806 & No. 516 Mainframes



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R_2, R_3 for 2 Drives (Floppy & Har

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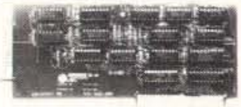

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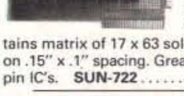

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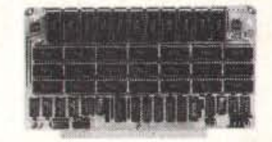

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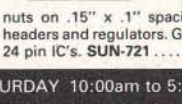

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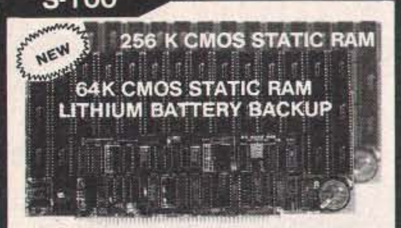

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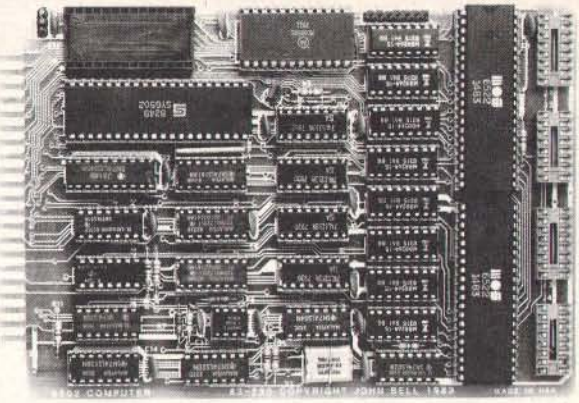

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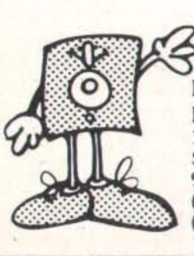

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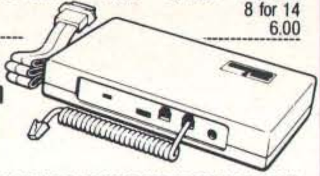

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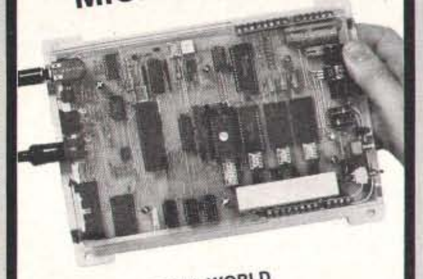

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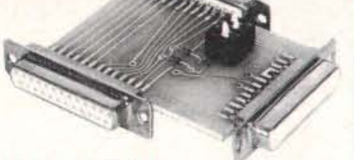

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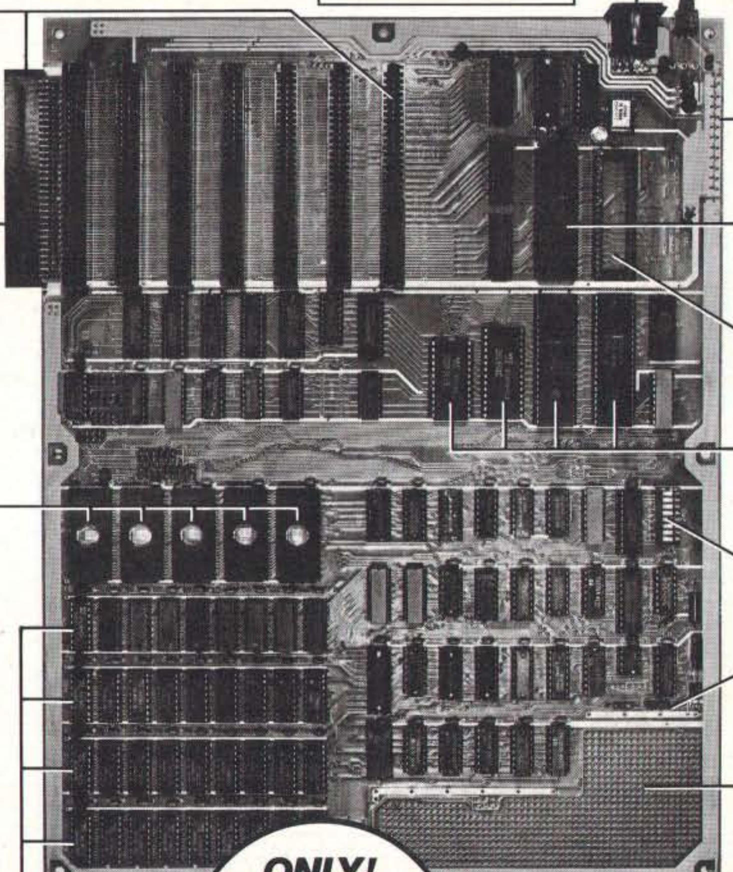

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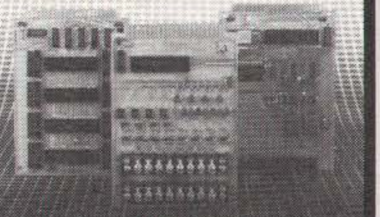

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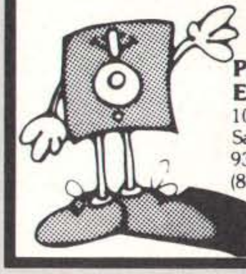

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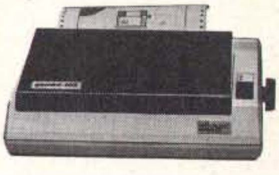

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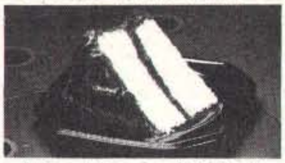

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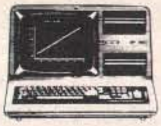

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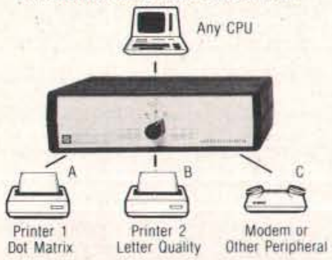

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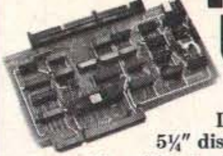

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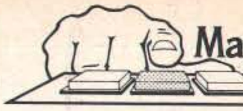

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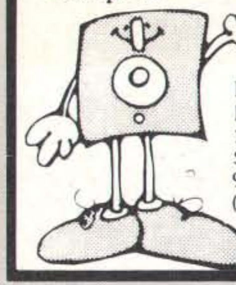

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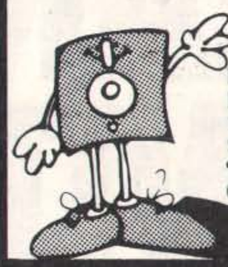

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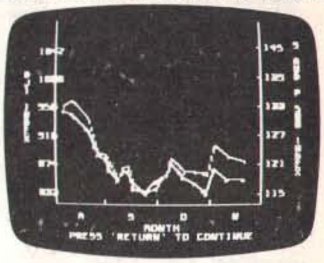

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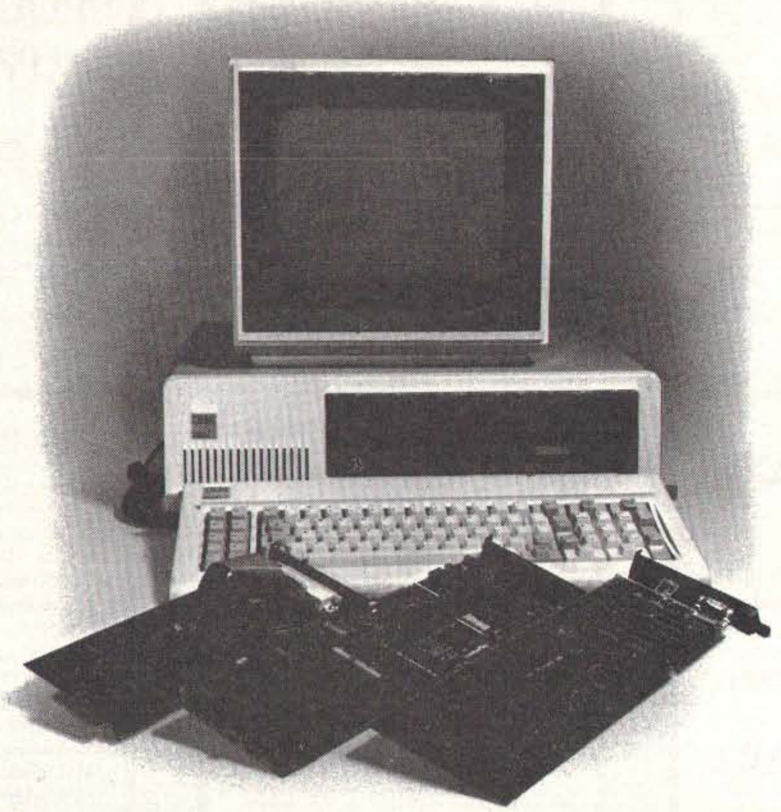

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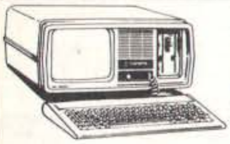

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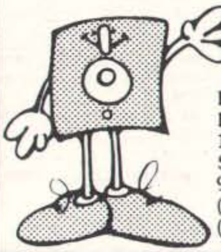

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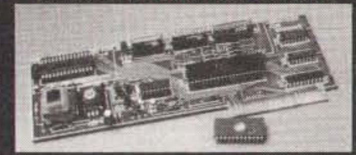

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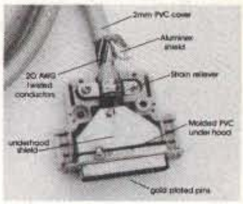

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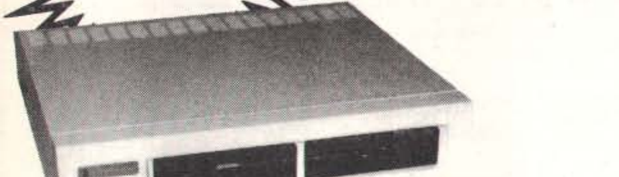

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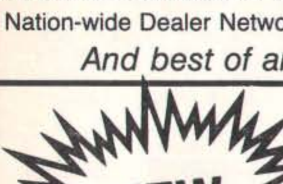

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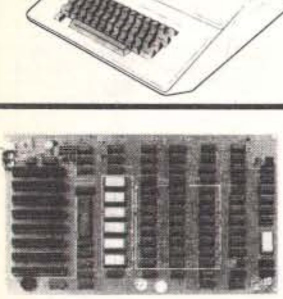

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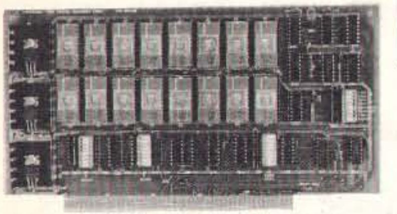

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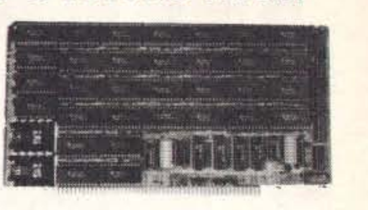

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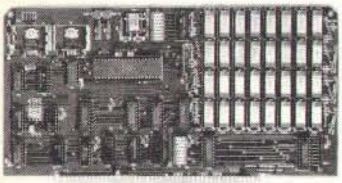

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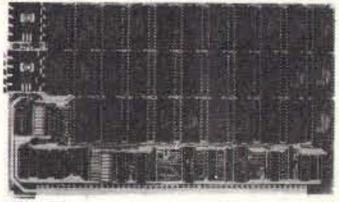

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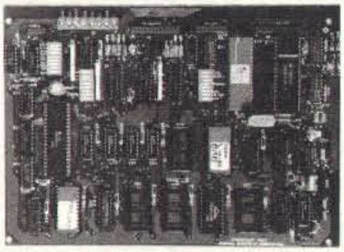

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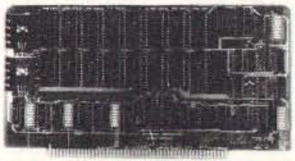

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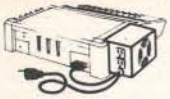

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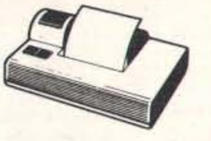

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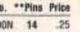

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74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	2.49
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INS8070N	40	CPU (64 bytes RAM)	29.95
INS8073N	40	CPU w/Basic Micro Interpreter	29.95
P8085A	40	CPU	4.95
8086	40	CPU 16-bit 5MHz	24.95
8088	40	CPU 8/16-bit	29.95
8155	40	HMOS RAM I/O Port-Timer	6.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Part No.	**Pins	Function	Price
Z80	40	CPU (MK3880N)(780C) 2MHz	$3.95
Z80-CTC	28	Counter Timer Circuit	3.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	10.95
Z80-DMA	40	Direct Memory Access Circuit	9.95
Z80-P10	40	Parallel I/O Interface Controller	3.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	12.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80-S10/9	40	Serial I/O	12.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	4.49
Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-P10	40	Parallel I/O Interface Controller	3.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	12.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80A-S10/9	40	Serial I/O	12.95
Z80B	40	CPU (MK3880N-6) 6MHz	9.95
Z80B-CTC	28	Counter Timer Circuit	12.95
Z80B-DART	40	Dual Asynch. Receiver/Transmitter	19.95
Z80B-P10	40	Parallel I/O Interface Controller	12.95
Z8001	48	CPU Segmented	44.95
Z8002	40	CPU Non-Segmented	34.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6500/6800/68000 SERIES

Part No.	**Pins	Function	Price
MC6502A	40	MPU with clock and RAM (2MHz)	6.95
MC6520	40	Peripheral Inter. Adapter	4.95
MC6800	40	MPU	2.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6809E	40	CPU (1MHz) External (Locking)	14.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	2.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	9.95
MC6850	24	Asynchronous Comm. Adapter	3.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	7.95
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC68488P	40	General Purpose Int. Adapter	9.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

Part No.	**Pins	Function	Price
INS8080A	40	CPU	2.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	2.95
DP8216	16	Bi-Directional Bus Driver	1.95
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.95
DP8307	20	8-bit Bi-Directional Receiver	2.95
DP8308	20	8-bit Bi-Directional Receiver	2.95
DP8310	20	Octal Latched Peripheral Driver	4.95
8741	40	8-bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

Part No.	**Pins	Function	Price
INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1793	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95
6843P	40	Floppy Disk Controller (1MHz)	29.95

SPECIAL FUNCTION

Part No.	**Pins	Function	Price
DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	32-seg VAC Fluor. Drvr. (20-pin pkg.)	3.25
IDM2909AJC	28	Microprocessor Sequencer	7.95
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

DYNAMIC RAMS

Part No.	**Pins		Price
1103	18	1024x1 (300ns)	.99
4027	**16**	**4096x1 (250ns)**	**2.49**
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	6.95 - 8/49.95
4164N-200	16	65,536x1 (200ns)	5.95 - 8/44.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1 (365ns)**	**.49 - 8/1.95**
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

Part No.	**Pins		Price
1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	1.95
2114	18	1024x4 (450ns)	1.49 - 8/9.95
2114L	18	1024x4 (450ns) L.P.	1.95 - 8/13.95
2114-2	18	1024x4 (200ns)	1.75 - 8/11.95
2114L-2	18	1024x4 (200ns) L.P.	2.25 - 8/14.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	4.95
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	2.95
5101	22	256x4 (450ns) CMOS	2.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	5.95
HM6116-4	24	2048x8 (200ns) CMOS	4.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8 (150ns) CMOS	39.95
27LS00	16	256x1 (80ns) L.P.	9.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

PROMS/EPROMS

Part No.	**Pins		Price
1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	5.95
TMS2532	24	4096x8 (450ns) NMC2532	6.95
TMS2564	28	8192x8 (450ns)	14.95
TMS2716	24	2048x8 (450ns) 3 voltage	9.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	5.95
2716Q-5	24	2048x8 (550ns)	4.49
2732	24	4096x8 (450ns)	6.95
2732A-3	24	4096x8 (300ns)	7.95
2732A-4	24	4096x8 (450ns) 21V	6.95
2732Q-4	24	4096x8 (550ns)	5.95
2758Q-A	24	1024x8 (450ns)	2.95
2764-4	28	8192x8 (450ns)	9.95
2764-3	28	8192x8 (300ns)	14.95
MM5204Q	24	512x8 (1us)	4.95
MCM68764	24	8192x8 (450ns)	24.95
27128	28	16,384x8 (450ns) 128K EPROM	59.95
74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	18	1024x4 PROM T.S.	6.95
74S478	24	1024x8 PROM T.S.	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
82S190	24	2048x8 (80ns)	14.95
82S191	24	2048x8 (80ns)	14.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4 PROM O.C. (82S190)	14.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	14.95

DATA ACQUISITION

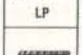
Part No.	**Pins	Function	Price
DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	1.49
MC1408L8	18	8-bit D/A Converter (DAC0808LCN)	2.25
ADC0803LCN	20	8-bit A/D Converter (±1/2LSB)	4.95
ADC0804	20	8-bit A/D Converter (1LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
ADC0817	40	8-bit A/D Converter (16-Ch. Multi.)	9.95
DAC1000	24	10-bit D/A Conv. Micro. Comp. (0.05%)	7.95
DAC1006	20	10-bit D/A Conv. Micro. Comp. (0.20%)	6.95
DAC1020	16	10-bit D/A Conv. (0.05% Lin.)	7.95
DAC1022	16	10-bit D/A Conv. (0.20% Lin.)	5.95
DAC1222	18	12-bit D/A Conv. (0.20% Lin.)	6.95
LM334Z		Constant Current Source	1.19
LM335Z		Temperature Transducer	1.40
LM399H		Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
AY-5-1013A	**40**	**30K Baud Uart (TR1602)**	**3.95**

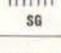
LOW PROFILE (TIN) SOCKETS

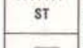
	1-9	10-99	100-up
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

SOLDERTAIL (GOLD) STANDARD

	1-9	10-99	100-up
8 pin SG	.30	.27	.25
14 pin SG	.43	.39	.37
16 pin SG	.47	.43	.41
18 pin SG	.53	.49	.47
24 pin SG	.69	.65	.61
28 pin SG	.81	.76	.72
36 pin SG	1.09	1.03	.97
40 pin SG	1.21	1.14	1.08







SOLDERTAIL STANDARD (TIN)

	1-9	10-99	100-up
14 pin ST	.29	.27	.25
16 pin ST	.34	.32	.30
18 pin ST	.38	.36	.34
20 pin ST	.45	.43	.41
24 pin ST	.49	.46	.43
28 pin ST	.69	.67	.63
40 pin ST	.99	.95	.89

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-9	10-99	100-up
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

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Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

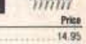
The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ . . . . $34.95 ea.
MM54104 Processor Chip . . . . $14.95 ea.

DT1057 - Expands the DT1050 vocabulary from 137 to over 260 words. Includes 2 ROMs and specs.
Part No. DT1057 . . . . $24.95 ea.

INTERSIL



*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
FE0203D		3½ Digit LCD Display for 7106 & 7116	19.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD	16.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

30009 1983 INTERSIL Data Book (1356p.) **$9.95**

NEW PRODUCT! 74HC High Speed CMOS

Part No.	**Pins	Price
74HC00	14	.59
74HC02	14	.59
74HC03	14	.75
74HC04	14	.59
74HCU04	14	.65
74HC08	14	.59
74HC10	14	.59
74HC11	14	.59
74HC14	14	.85
74HC20	14	.59
74HC27	14	.59
74HC32	14	.75
74HC42	16	.99
74HC51	14	.75
74HC58	14	.75
74HC73	14	.79
74HC74	14	.79
74HC75	16	.89
74HC76	16	.79
74HC85	16	1.59
74HC86	14	.69
74HC107	14	.79
74HC109	16	.79
74HC112	16	.79
74HC113	14	.79
74HC132	14	.99
74HC137	16	1.95
74HC138	16	1.09
74HC139	16	.99
74HC147	16	1.19
74HC151	16	.89
74HC153	16	.99
74HC154	24	2.49
74HC157	16	.89
74HC158	16	.89
74HC160	16	1.29
74HC161	16	1.29
74HC162	16	1.29
74HC163	16	1.29
74HC164	14	1.29
74HC165	16	2.79
74HC173	16	1.69
74HC174	16	.99
74HC175	16	.99
74HC192	16	1.39
74HC193	16	1.39
74HC194	16	1.09
74HC195	16	1.09
74HC237	16	2.95
74HC240	20	1.95
74HC241	20	1.95
74HC242	14	1.95
74HC243	14	1.95
74HC244	20	1.95
74HC245	20	2.49
74HC251	16	.89
74HC253	16	.99
74HC257	16	.89
74HC259	16	1.49
74HC266	14	1.19
74HC273	20	2.89
74HC280	14	3.95
74HC373	20	2.39
74HC374	20	2.39
74HC390	16	1.49
74HC393	14	1.49
74HC533	20	2.39
74HC534	20	2.39
74HC595	16	3.95
74HC688	20	3.19
74HC4002	14	.59
74HC4017	16	2.19
74HC4020	16	1.39
74HC4024	14	1.59
74HC4040	16	1.39
74HC4060	16	1.39
74HC4075	14	.59
74HC4078	14	.69
74HC4511	16	2.89
74HC4514	24	3.79
74HC4538	16	2.39
74HC4543	16	3.49

74HCU04 is unbuffered. All others are buffered.

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$3.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	3.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	3.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	7.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	7.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	7.95

30012 1982 NATIONAL PAL Data Book (176p.) . . **$5.95**

74C—C/MOS

Part No.	**Pins	Price
74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.69
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19
74C95	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	1.19
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39
74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.69
80C97	16	.69

LINEAR

Part No.	**Pins	Price
TL071CP	8	.79
TL072CP	8	1.39
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LF347N	14	1.49
LM348N	14	.99
LM350K		4.95
LF355N	8	1.10
LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
TL494CN	16	3.95
TL496CP	8	1.19
NE531V	8	2.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.99
NE570N	16	3.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
LM1458CN	8	.59
LM1488N	14	.89
LM1489N	14	.89
LM1496N	14	1.95
LM1800N	16	2.49
LM1871N	18	2.95
LM1872N	18	3.25
LM1877N-9	14	2.49
LM1889N	18	2.25
LM1896N	14	2.95
LM2002T		1.95
LM3189N	16	1.59
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	2.95
LM3915N	18	2.95
LM3916N	18	2.95
RC4136N	**14**	**1.25**
RC4151NB	8	1.95
RC4194TK		4.49
NE5532	8	2.49
NE5534	8	1.69
ICL8038B	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19

MORE AVAILABLE

30003 1982 Nat. Linear Data Book (1952 pgs.) . **$11.95**

Circle 200 on inquiry card.

VOICE SYNTHESIZER FOR APPLE AND COMMODORE

• Over 250 word vocabulary - affixes allow the formation of more than 500 words • Built-in amplifier, speaker, volume control, and audio jack • Recreates a clear, natural male voice • Plug-in user ready with documentation and sample software • Case size: 7¼"L × 3¼"W × 1-3/8"H

APPLICATIONS:

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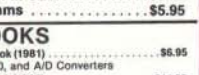
- Handicap Aid
- Games

The JE520 VOICE SYNTHESIZER will plug right into your computer and allow you to enhance almost any application. Utilizing National Semiconductor's DIGITALKER™ Speech Processor IC (with four custom memory chips), the JE520 compresses natural speech into digital memory, including the original inflections and emphases. The result is an extremely clear, natural vocalization.

Part No.	Description	Price
JE520CM	For Commodore 64 & VIC-20	$114.95
JE520AP	For Apple II, II+, and //e	$149.95

Micro-Logic Corp. MICRO-CHARTS



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ML-Z80	Z80 CPU	$5.95
ML-8080A	8080A/8085A	$5.95
ML-6502	6502 (65XX)	$5.95
ML-8048	8048, Relatives	$5.95
ML-7400	5400/7400 TTL Pin-Outs	$5.95
ML-ALGO	Basic Algorithms	$5.95

BOOKS

30001	**National CMOS Data Book (1981)** (640 pages) 74C, CD4000, and A/D Converters	$6.95
30003	**National Linear Data Book (1982)** (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30008	**National Memory Data Book (1980)** (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
30009	**Intersil Data Book (1983)** (1356 pages) Complete line.	$9.95
30010	**National Audio/Radio Handbook (1980)** (240 pages) Pre-Amps, AM, FM & FM Stereo, Power Amps	$5.95
30012	**National PAL Data Book (1982)** (176 pages) Application Notes, Linear Briefs, etc.	$5.95
30013	**Zilog Data Book (1983)** (641 pages) Microprocessors and Support Chips	$7.95
210830	**Intel Memory Components Handbook (1983)** (798 pages) Contains all Application Notes, Article Reprints, Data Sheets, and other design information on Intel's RAMs, EPROMs, E²PROMs & Bubble Memories.	$14.95
210844	**Intel Microprocessor & Peripheral Handbook (1983)** (1027 pages) Contains Data Sheets on all of Intel's Microprocessors and Peripherals.	$14.95

4-Digit Fluorescent Alarm Clock Kit

• Bright 4-digit 0.5" high display • 10 minute snooze alarm • AM/PM indicator • Automatic display dimmer

The JE750 Clock Kit is a versatile 12-hour digital clock with 24-hour alarm. The clock has a bright 0.5" high blue-green flourescent display. The 24-hour alarm allows the user to disable the alarm and immediately re-enable the alarm to activate 24 hours later. The kits includes all documentation, components, case and wall transformer. Size: 6-5/8"L × 3¼"H × 1¾"D.

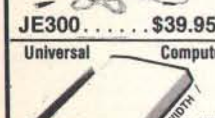
JE750 Alarm Clock Kit **$29.95**

Jameco ELECTRONICS Digital Thermometer Kit

Dual sensors — switch controls for indoor/outdoor or dual monitoring — can be extended to 500 feet. Continuous LED .8" ht. display. Range: -40°F to 199°F, -40°C to 100°C. Accuracy ±1° nominal. Calibrate for Fahrenheit/Celsius. Simulated walnut case. AC wall adapter included. Size: 6⅝"L x 3¼"H x 1¾"D.

JE300 ...... **$39.95**

Universal Computer Keyboard Enclosures



"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

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DTE-14	Panel Width 13.5"	$29.95
DTE-20	Panel Width 19.25"	$34.95
DTE-22	Panel Width 21.375"	$39.95

CARD-EDGE CONNECTOR
Mates with double-sided 1/16" PC board with contact fingers on .100" centers

CARD-EDGE CONNECTORS

Part No.	No. of Contacts/ Conductors	1-9	10-99	100+
C20	20	2.39	2.09	1.89
C26	26	2.69	2.39	2.09
C34	34	3.29	2.95	2.59
C40	40	3.69	3.29	2.89
C50	50	4.39	3.95	3.39

SOCKET CONNECTOR
Mates with 2 rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles

SOCKET CONNECTORS

Part No.	No. of Contacts/ Conductors	1-9	10-99	100+
S20	20	1.39	1.25	1.09
S26	26	1.69	1.49	1.35
S34	34	2.09	1.79	1.59
S40	40	2.29	2.09	1.79
S50	50	2.69	2.39	2.09
S60	60	3.39	2.95	2.59

SOLDER TRANSITION CONNECTORS

FOR PERMANENT TERMINATION TO PRINTED CIRCUIT BOARDS

Part No.	No. of Contacts	1-9	10-99	100+
ST20	20	1.15	.99	.89
ST26	26	1.25	1.15	.99
ST34	34	1.49	1.35	1.15
ST40	40	1.69	1.55	1.35
ST50	50	1.89	1.69	1.49

MALE CONNECTOR

Mates with Socket Connector .10" × .10"

Part No.	No. of Contacts/ Conductors	1-9	10-99	100+
M20	20	4.09	3.65	3.19
M26	26	4.49	3.95	3.49
M34	34	4.95	4.49	3.95
M40	40	5.49	4.89	4.29
M50	50	6.49	5.75	4.95

36-Pin CENTRONICS RIBBON CONNECTORS 24-Pin IEEE488

Part No.	No. of Contacts/ Style	1-9	10-99	100+
CEN14M	14 Male	6.39	5.49	4.49
CEN14F	14 Female	6.19	5.29	4.29
CEN24M	24 Male	7.95	6.95	5.95
CEN24F	24 Female	7.69	6.79	5.75
CEN36M	36 Male	8.69	7.59	6.49
CEN36F	36 Female	9.75	8.95	7.95

D-SUB CONNECTORS

Part No.	No. of Contacts/ Style	1-9	10-99	100+
CDE9P	9 Male	2.95	2.65	2.29
CDE9S	9 Female	3.39	3.09	2.69
CDA15P	15 Male	3.95	3.55	3.09
CDA15S	15 Female	4.75	4.19	3.69
CDB25P	25 Male	5.49	4.79	4.25
CDB25S	25 Female	5.95	5.49	4.85
CDC37P	37 Male	7.79	6.95	6.09
CDC37S	37 Female	8.95	7.95	6.95

28AWG FLAT GREY CABLE

Part No.	No. of Contacts/ Conductors	Connector & Wire Type	Price Per Foot
171-9	9	28AWG Flat Stranded	.19
171-14	14	28AWG Flat Stranded	.25
171-15	15	28AWG Flat Stranded	.27
171-16	16	28AWG Flat Stranded	.29
171-20	20	28AWG Flat Stranded	.36
171-24	24	28AWG Flat Stranded	.45
171-25	25	28AWG Flat Stranded	.47
171-26	26	28AWG Flat Stranded	.49
171-34	34	28AWG Flat Stranded	.62
171-36	36	28AWG Flat Stranded	.65
171-37	37	28AWG Flat Stranded	.69
171-40	40	28AWG Flat Stranded	.75
171-50	50	28AWG Flat Stranded	.89

CUSTOM ASSEMBLIES

Use the part numbers from the connectors and cable to order your own custom assembled cables.

EXAMPLE: If you desire a 25-foot cable with a male "Centronics" connector on one end, and a female "Centronics" connector on the other end, you would order:

CEN36M-25' -CEN36F CUSTOM
$8.69 (CEN36M) + 9.75 (CEN36F) = ... **$18.44**
.65 × 25 (25 feet 36 cond. cable) = ... **$16.25**
2.00 Set-up charge on all custom cables = ... **$ 2.00**
This (CEN36M-25' -CEN36F CUSTOM) Cable would cost **$36.69**

Please specify "CUSTOM" after the part no. to ensure your order will be filled correctly. (**Important**: Please specify cable in FEET, not inches)

ALL CUSTOM ASSEMBLIES MUST BE PREPAID BEFORE ASSEMBLY. THERE ARE NO RETURNS ON CUSTOM CABLE ASSEMBLIES. $2.00 SET-UP CHARGE (PER STYLE) ON ALL CUSTOM CABLES.

ACCESSORIES FOR APPLE* COMPUTERS

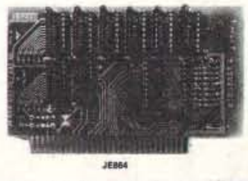
Numeric/Auxiliary Keypad for APPLE //e*

JE614

The JE614 is a newly introduced numeric/auxiliary keypad for the APPLE //e.* It offers the flexibility of a 10-key pad and the convenience of 23 directly accessible functions. Screen manipulating functions make word processing a snap and cursor controls make the keypad ideal for VisiCalc** users. The JE614 Keypad is housed in a durable metal enclosure and is color-coordinated with your APPLE //e computer. Operation of the keypad can begin within minutes from unpacking. Special functions include: Home, Clear, Clear to End of Screen, Scroll-Up, Scroll-Down, Tab, Delete, Left, Right, Up and Down. Each key has auto-repeat.

JE614 Assembled and Tested **$89.95**

Extended 80 Column/64K RAM Card for APPLE //e*



JE864

Now you can double the memory capacity and get an 80 column display format for your APPLE //e computer at an affordable price. Just plug the JE864 card into your APPLE and expand your display to 80-characters per line. Perfect for word processing. The JE864 also features 64K bytes of additional memory to allow programming not possible with standard APPLE //e computers.

Board: High density board design squeezes 64K bytes of RAM onto a 2½" × 4½" board • Fully tested to assure proper operation.

Uses: Word processing — displays 1000 more characters per screen • Extra memory allows running of extremely large programs • Ultra High Resolution Graphics (when software available)

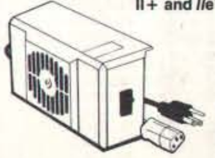
JE864 Assembled and Tested **$149.95**

Switching Power Supply for APPLE II, II+ and //e*

• Can drive four floppy disk drives and up to eight expansion cards • Short-circuit and overload protection • Fits inside Apple computer • Fully regulated: +5V @ 5A, +12V @ 3A, -5V @ .5A, -12V @ .5A • Apple-type plug in power cord included • Size: 9¼"L x 3½"W x 2½"H • Weight: 2 lbs.

Part No. KHP4007 .... $79.95

Cooling Fan for APPLE II, II+ and //e*



• Snaps on the side of APPLE II, II+ and //e* enclosures • Eliminates overheating problems, thereby boosting reliability and operation life of computer • Switch on front of fan serves as power switch for fan, computer, and provides extra outlet.

Part No. APF-1 .... $49.95

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POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING

Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.

Part No. PS94V0S .... **$39.95 each**

POWER SUPPLY 4-Channel Switching - Apple Compatible

Microprocesser, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ± 10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.

Part No. FCS-604A .... **$69.95 each**

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
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Send S.A.S.E. for Monthly Sales Flyer!

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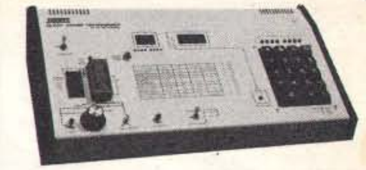

JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz., < 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¾"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer **$995.00**
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers. The JE665 can be interfaced to any computer with an RS232 port. Information is also provided for interfacing to any CP/M system with an RS232 port.

JE664-ARS EPROM Programmer w/JE665 Option **$1195.00**
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES - The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

P/N	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI (25V)	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI, (25V)	$14.95
JM16B	TMS2716	Motorola, TI (+5, -5, +12)	$14.95
JM32A	TMS2532	Motorola, TI (25V)	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel (25V)	$14.95
JM32C	2732A (21V)	Fujitsu, Intel (21V)	$14.95
JM64A	MCM68764, MCM68L764	Motorola (21V)	$14.95
JM64B	2764	Intel (21V)	$14.95
JM64C	TMS2564	TI (25V)	$14.95

UV-EPROM Eraser

8 Chips — 51 Minutes

1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

DE-4 UV-EPROM Eraser ... $79.95
UVS-11EL Replacement Bulb $16.95

5¼" APPLE™ COMPATIBLE DISK DRIVE

• Uses Shugart SA390 mechanics • 143K formatted storage • 35 tracks — compatible with Apple controller • Complete with connector and cable — just plug into your disk controller card • Size: 6"L × 3½"W × 8-9/16"D • Weight: 4¼ lbs.

Part No. ADD-514 $195.95

8" FLOPPY DISK DRIVE

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

FDD100-8 . . $169.95 ea.

IBM MEMORY EXPANSION KIT

SAVE HUNDREDS OF $$$ BY UPGRADING MEMORY BOARDS YOURSELF!

Most of the popular memory boards allow you to add an additional 64K, 128K, 192K, or 256K. The IBM64K Kit will populate these boards in 64K byte increments. The kit is simple to install — just insert the nine 64K RAM chips in the provided sockets and set the two groups of switches. Directions are included.

IBM64K (Nine 200ns 64K RAMs) $49.95

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K

****Model 1 = From 4K to 16K Requires (1) One Kit**
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

****Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —**

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Easy to install kit comes complete with 8 ea. 4164-2 (200ns) 64K dynamic RAMs & conversion documentation. Converts TRS-80 color computers with E circuit boards, & all new color computers to 32K. Minor modifications of 32K memory will allow the use of all the 64K of the dynamic RAM providing you have a FLEX DOS operating system.

TRS-64K2 .... $44.95

Circle 200 on inquiry card.

DoKay

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DoKay

STATIC RAMS

2101	256 x 4 (450ns)	1.90
5101	256 x 4 (450ns) (cmos)	3.90
2102-1	1024 x 1 (450ns)	.88
2102L-4	1024 x 1 (450ns) (LP)	.98
2102L-2	1024 x 1 (250ns) (LP)	1.45
2111	256 x 4 (450ns)	2.45
2112	256 x 4 (450ns)	2.95
2114	1024 x 4 (450ns)	8/9.90
2114-25	1024 x 4 (250ns)	8/9.95
2114L-4	1024 x 4 (450ns) (LP)	8/11.95
2114L-3	1024 x 4 (300ns) (LP)	8/12.45
2114L-2	1024 x 4 (200ns) (LP)	8/12.95
2147	4096 x 1 (55ns)	4.90
TMS4044-4	4096 x 1 (450ns)	3.45
TMS4044-3	4096 x 1 (300ns)	3.95
TMS4044-2	4096 x 1 (200ns)	4.45
MK4118	1024 x 8 (250ns)	9.90
TMM2016-200	2048 x 8 (200ns)	4.10
TMM2016-150	2048 x 8 (150ns)	4.90
TMM2016-100	2048 x 8 (100ns)	6.10
HM6116-4	2048 x 8 (200ns) (cmos)	4.70
HM6116-3	2048 x 8 (150ns) (cmos)	4.90
HM6116-2	2048 x 8 (120ns) (cmos)	8.90
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.90
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.90
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	9.95
Z-6132	4096 x 8 (300ns) (Qstat)	33.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.95
UPD411	4096 x 1 (300ns)	2.95
MM5280	4096 x 1 (300ns)	2.95
MK4108	8192 x 1 (200ns)	1.90
MM5298	8192 x 1 (250ns)	1.80
4116-300	16384 x 1(300ns)	8/10.75
4116-250	16384 x 1(250ns)	8/10.95
4116-200	16384 x 1(200ns)	8/11.95
4116-150	16384 x 1(150ns)	8/13.95
4116-120	16384 x 1(120ns)	8/28.95
2118	16384 x 1(150ns) (5v)	4.90
4164-200	65536 x 1(200ns) (5v)	5.90
4164-150	65536 x 1(150ns) (5v)	6.90

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.45
2708	1024 x 8 (450ns)	3.90
2758	1024 x 8 (450ns) (5v)	5.90
2716	2048 x 8 (450ns) (5v)	3.90
2716-1	2048 x 8 (350ns) (5v)	5.90
TMS2516	2048 x 8 (450ns) (5v)	5.45
TMS2716	2048 x 8 (450ns)	7.90
TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	4.90
2732-250	4096 x 8 (250ns) (5v)	8.90
2732-200	4096 x 8 (200ns) (5v)	10.95
2764	8192 x 8 (450ns) (5v)	9.90
2764-250	8192 x 8 (250ns) (5v)	13.95
2764-200	8192 x 8 (200ns) (5v)	23.95
TMS2564	8192 x 8 (450ns) (5v)	16.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	38.95
27128	16384 x 8Call	Call

5v = Single 5 Volt Supply

74LS00

74LS00	.23	74LS173	.68
74LS01	.24	74LS174	.54
74LS02	.24	74LS175	.54
74LS03	.24	74LS181	2.10
74LS04	.23	74LS189	8.90
74LS05	.24	74LS190	.88
74LS08	.27	74LS191	.88
74LS09	.28	74LS192	.78
74LS10	.24	74LS193	.78
74LS11	.34	74LS194	.68
74LS12	.34	74LS195	.68
74LS13	.44	74LS196	.78
74LS14	.58	74LS197	.78
74LS15	.34	74LS221	.88
74LS20	.24	74LS240	.94
74LS21	.28	74LS241	.98
74LS22	.24	74LS242	.98
74LS26	.28	74LS243	.98
74LS27	.28	74LS244	1.25
74LS28	.34	74LS245	1.45
74LS30	.24	74LS247	.74
74LS32	.28	74LS248	.98
74LS33	.54	74LS249	.98
74LS37	.34	74LS251	.58
74LS38	.34	74LS253	.58
74LS40	.24	74LS257	.58
74LS42	.48	74LS258	.58
74LS47	.74	74LS259	2.70
74LS48	.74	74LS260	.58
74LS49	.74	74LS266	.54
74LS51	.24	74LS273	1.45
74LS54	.28	74LS275	3.30
74LS55	.28	74LS279	.48
74LS63	1.20	74LS280	1.95
74LS73	.38	74LS283	.68
74LS74	.34	74LS290	.88
74LS75	.38	74LS293	.88
74LS76	.38	74LS295	.98
74LS78	.48	74LS298	.88
74LS83	.59	74LS299	1.70
74LS85	.68	74LS323	3.45
74LS86	.38	74LS324	1.70
74LS90	.54	74LS352	1.25
74LS91	.88	74LS353	1.25

74LS92	.54	74LS363	1.30
74LS93	.54	74LS364	1.90
74LS95	.74	74LS365	.48
74LS96	.88	74LS366	.48
74LS107	.38	74LS367	.44
74LS109	.38	74LS368	.44
74LS112	.38	74LS373	1.35
74LS113	.38	74LS374	1.35
74LS114	.38	74LS377	1.35
74LS122	.44	74LS378	1.13
74LS123	.78	74LS379	1.30
74LS124	2.85	74LS385	1.85
74LS125	.48	74LS386	.44
74LS126	.48	74LS390	1.15
74LS132	.58	74LS393	1.15
74LS133	.58	74LS395	1.15
74LS136	.38	74LS399	1.45
74LS137	.98	74LS424	2.90
74LS138	.54	74LS447	.36
74LS139	.54	74LS490	1.90
74LS145	1.15	74LS624	3.95
74LS147	2.45	74LS640	2.15
74LS148	1.30	74LS645	2.15
74LS151	.54	74LS668	1.65
74LS153	.54	74LS669	1.85
74LS154	1.85	74LS670	1.45
74LS155	.68	74LS674	9.60
74LS156	.68	74LS682	3.15
74LS157	.64	74LS683	3.15
74LS158	.58	74LS684	3.15
74LS160	.68	74LS685	3.15
74LS161	.64	74LS688	2.35
74LS162	.68	74LS689	3.15
74LS163	.64	74LS763	23.95
74LS164	.68	81LS95	1.45
74LS165	.94	81LS96	1.45
74LS166	1.90	81LS97	1.45
74LS168	1.70	81LS98	1.45
74LS169	1.70	25LS2521	2.75
74LS170	1.45	25LS2569	4.20

6500

1MHZ

6502	4.90
6504	6.90
6505	8.90
6507	9.90
6520	4.30
6522	7.90
6532	9.90
6545	21.50
6551	10.85

2 MHZ

6502A	6.90
6522A	9.90
6532A	10.95
6545A	26.95
6551A	10.95

3 MHZ

6502B	13.95

6800

68000	58.95
6800	3.90
6802	7.90
6808	12.90
6809E	18.95
6809	10.95
6810	2.90
6820	4.30
6821	3.20
6828	13.95
6840	11.95
6843	33.95
6844	24.95
6845	13.95
6847	10.95
6850	3.20
6852	15.70
6860	9.90
6862	10.95
6875	6.90
6880	2.20
6883	21.95
68047	23.95
68488	18.95

6800 1MHZ

68B00	9.95
68B02	21.25
68B09E	28.95
68B09	28.95
68B10	6.90
68B21	6.90
68B45	18.95
68B50	5.90

8000

8035	5.90
8039	6.90
INS-8060	16.95
INS-8073	23.95
8080	3.90
8085	5.90
8085A-2	10.95
8086	28.95
8087	CALL
8088	38.95
8089	88.95
8155	6.90
8155-2	7.90
8156	6.90
8185	28.95
8185-2	38.95
8741	38.95
8748	23.95
8755	23.95

Circle 137 on inquiry car

8200

8202	23.95
8203	38.95
8205	3.45
8212	1.75
8214	3.80
8216	1.70
8224	2.20
8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	4.40
8250	9.95
8251	4.45
8253	6.90
8253-5	7.90
8255	4.45
8255-5	5.20
8257	7.90
8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	9.00
8272	6.45
8283	6.45
8284	5.45
8286	6.45
8287	6.45
8288	24.00
8289	48.95

Z-80

2.5 Mhz

Z80-CPU	3.90
Z80-CTC	4.45
Z80-DART	9.95
Z80-DMA	13.95
Z80-PIO	4.45
Z80-SIO/0	15.95
Z80-SIO/1	15.95
Z80-SIO/2	15.95
Z80-SIO/9	15.95

4.0 Mhz

Z80A-CPU	4.90
Z80A-CTC	4.90
Z80A-DART	10.95
Z80A-DMA	15.95
Z80A-PIO	4.90
Z80A-SIO/0	15.95
Z80A-SIO/1	15.95
Z80A-SIO/2	15.95
Z80A-SIO/9	15.95

6.0 Mhz

Z80B-CPU	12.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	18.95

ZILOG

Z6132	33.95
Z8671	38.95

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1791	23.95
1793	25.95
1795	48.95
1797	48.95
2791	53.95
2793	53.95
2795	58.95
2797	58.95
6843	33.95
8272	38.95
UPD765	38.95
MB8876	28.95
MB8877	33.95
1691	16.95
2143	17.95

UARTS

AY3-1014	6.90
AY5-1013	3.90
AY3-1015	6.90
PT-1472	9.90
TR1602	3.90
2350	9.90
2651	8.90
TMS6011	5.90
IM6402	7.90
IM6403	8.90
INS8250	9.95

INTERFACE

8T26	1.54
8T28	1.84
8T95	.88
8T96	.88
8T97	.88
8T98	.88
DM8131	2.90
DP8304	2.24
DS8835	1.94
DS8836	.98

VOLTAGE REGULATORS

7805T	.74	7905T	.84
78MO5C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C,T = TO-220　K = TO-3　L = TO-92

DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call
ST = SOLDERTAIL		
8 pin WW	.58	.48
14 pin WW	.68	.51
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75
WW = WIREWRAP		
16 pin ZIF	6.70	call
24 pin ZIF	9.90	call
28 pin ZIF	9.95	call

ZIF = TEXTOOL (Zero Insertion Force)

CRYSTALS

32.768khz	1.90
1.0 mhz	4.90
1.8432	4.90
2.0	3.90
2.097152	3.90
2.4576	3.90
3.2768	3.90
3.579535	3.90
4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

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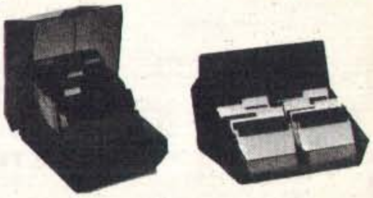

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P/N SP64, (64K, Clk, S, P)		319
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BMC		
12" Green	129	89
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RGB IBM Lookalike	700	545

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IBM 5¼" SS SD	10/60	43
IBM 5¼" SS DD	10/65	47
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VERBATIM 550-01 DS	10/55	34
MAXELL MD1 SS	10/50	29
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DYSAN	104/1D	107/1D	NA	45.00

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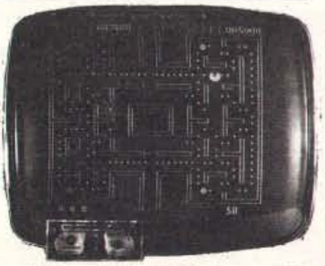

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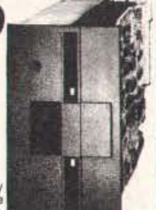
These units accept standard composit video signals generated by most personal computers including the Apple and IBM. Attach it your computer and in second you are shooting down Klingons in wide screen video.

MOT-BW23 35 Lbs. Monitors are open frame and for safety should be enclosed. Wood grained enclosure for above $35.00 additional CAL-ENC23 15 Lbs.

SPECIAL

Shugart 410

$129



These Shugart 410 5¼" disk drives are all factory fresh 1983 production, recently purchased from the Four Phase Division of the Motorola Corporation.

These disk drives are **single sided 80 track**(96 TPI) suitable for use with the Radio Shack Model 1 and Model 3. Or any other application that can support an 80 track second drive such as the IBM/PC. The 410 is full height and functionally the same as the Tandon TM 100-3. Complete with power connector and installation manual.

When these Shugart 410's are liquidated the price will revert to our regular price of $249. SHU-SA410

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4116 150ns.	450ns.
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4164 150ns.	6116 200ns.

2764 EPROM SALE $5.95

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4164 150ns. 64K 128 refresh	ICM-4164150	5.95	5.55	5.19
41256 150ns. 256K	ICM-41256150	Available Mar.84		
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2112 450ns. 2K static	ICM-2112450	2.99	2.85	2.75
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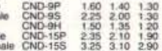
2817 EEROM. 2K x 8	ICE-2817	45.00	39.00	36.50

CONNECTORS

S-100 Gold



DB25P

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57-30360f male	CNC-r36S	7.95	6.75	5.90
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20 pin socket	CNI-DS20	2.75	1.85	1.60
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26 pin socket	CNI-DS26	3.50	2.40	2.15
34 pin edge	CNI-DE34	4.95	4.50	3.50
34 pin socket	CNI-DS34	4.50	3.95	3.15
50 pin edge	CNI-DE50	5.95	5.60	4.90
50 pin socket	CNI-DS50	4.95	4.60	3.80

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DE9S female	CND-9S	2.25	2.00	1.30
DE hood	CND-9H	1.50	1.35	1.20
DA15P male	CND-15P	2.35	2.10	1.90
DA15S female	CND-15S	3.25	3.10	2.90
DA15 hood	CND-15H	1.60	1.35	1.30
DB25P male	CND-25P	1.95	1.75	1.35
DB25S female	CND-25S	2.95	2.55	1.65
DB25 hood	CND25H	1.35	1.15	.77
DC37P male	CND-37P	4.20	3.95	3.65
DC37S female	CND-37S	5.95	5.75	5.50
DC37 hood	CND-37H	2.25	1.95	1.65
DD50P male	CND-50P	5.50	5.10	4.75
DD50 hood	CND-50H	2.60	2.40	2.10
Hardware 2/set	CND-2HS	.89	.69	.42
AMPHENOL / CENTRONICS TYPE				
57-30360 36/P	CNC-36P	7.95	6.35	3.97
IEEE488, C'dor	CND-24P	7.95	6.35	5.35
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8" 3 AC Dbl/S	CNP-3DS	1.69	1.09	.69
5¼" 4 pin D.C.	CNP-4DC	1.79	1.19	.99
3 pin DIN recpt.	CNP-D3P	2.59	1.99	1.59

BLOWOUT SALE

$169

California Digital has recently participated in the purchase of several thousand Siemens FDD 100-8 floppy disk drives. These units are electronically and physically similiar to that of the Shugart 801R. All units are new and shipped in factory sealed boxes. Manual and power connectors supplied free upon request. Your choice 115 Volt. 60 Hz. or 230 Volt. 50Hz.

NOTE! European customers, we have a large quantity of 230 volt 50 Hz. units warehoused in Frankfort Germany. Arrangements can be made to will call these drives in quantities of 50 or more in Frankfort reducing import duty and freight charges.

REMEX DOUBLE SIDED $219

California Digital has just purchased a large quantity of Remex RFD-4000 **Eight inch double sided** disk drives. Remex is the only double sided disk drive that has an double gimbal mounted head assembly that guaranties lower head tracking. This drive is mechanically solid. Remex has always been known for producing premiere products for the floppy disk market. The Remex company is a subsidiary of the Ex-cell-o Corporation, a Fortune 500 Company.

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SHUGART 810 Half Height	385	375	365
SIEMENS FDD 100-8	169	169	159
TANDON 848E-1 Half Height	369	359	349
Eight Inch Double Sided Drives			
SHUGART SA851R	495	485	475
SHUGART 860 Half Height	485	475	459
QUME 842 "QUME TRACK 8"	459	459	449
TANDON 848E-2 Half Height	459	447	465
REMEX RFD-4000	219	219	209
MITSUBISHI M2894-63	379	375	369
MITSUBISHI M2896-63 Half Ht.	459	449	409
Five Inch Single Sided Drives			
SHUGART SA400L	235	229	225
SHUGART SA410 96TPI/80 Trk.	129	119	call
SHUGART SA200 ⅔ Height	159	149	139
TANDON TM100-1	189	179	175
Five Inch Double Sided Drives			
REMEX RFD480 IBM compatible	199	189	175
SHUGART SA450	319	309	299
SHUGART SA455 Half Height	259	249	239
SHUGART SA465 Half Ht. 96TPI	289	279	269
TANDON TM50-2 Half Height	215	209	199
TANDON TM55-4 half Ht. 96TPI	329	319	309
TANDON 100-2	279	269	259
TANDON 101-4 96TPI 80 Track	369	355	350
MITSUBISHI 4851 Half Height	259	249	245
MITSUBISHI 4853 ½ Ht. 96TPI	339	329	319
MITSUBISHI 4854 ½ Ht., 8" elec.	465	449	439
QUME 142 Half Height	239	229	219
TEAC FD-55B Half Height	299	389	275
Three Inch Disk Drives			
SHUGART SA300 with diskette	229	219	209
Five Inch Winchester Hard Disk Drives			
SHUGART 612 13 M/Bytes	895	865	825
SHUGART 706 6 M/Byte, Half Ht	795	775	755
SHUGART 712 13 M/Byte, ½ Ht.	895	865	825
SEAGATE 506 6 M/Byte	465	445	425
TANDON 503 19 M/Byte	895	875	855

Upon request, all drives are supplied with power connectors and manual

ENCLOSURES

California Digital manufactures an asortment of stock and custom disk drive enclosures. If the volume is justified we will custom design an enclosure for your application. The following stock disk drive enclosures are available. All include power supplies the 8" enclosures are supplied with exhaust fans.

Horizontal mount two 8" full height drives.	$279.00
Vertical mount two full height 8" disk drives.	$299.00
Horizontal mount one full height or two half height 8" disk drives.	$239.00
Vertical mount two full height 5¼" disk drives	$139.00

VISA

master charge

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. ● COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.
Retail location: 15608 Inglewood Avenue, Lawndale 90260.

TOLL FREE ORDER LINE
(800) 421-5041
TECHNICAL & CALIFORNIA
(213) 643-9001

California Digital

Post Office Box 3097 B • Torrance, California 90503

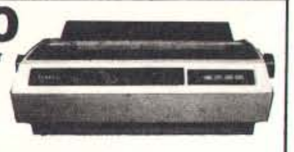
LIBERTY FREEDOM 50 $475

The Liberty Freedom 50 terminal features detachable keyboard with 93 keys including 10 function keys, 15 graphic symbols, and DIP switch selectable character set for 7 foreign languages. The 12 inch etched non-glare green phosphor screen displays 24 rows by 80 characters in 7x9 matrix with true descenders. Self test and 25th data display row also included. Switch selectable baud rates from 110-19,200 baud. Screen attributes do not use display memory, allowing operator to display a full 1920 characters. Emulates 5 popular CRT terminals for easy software configuration. Switch selectable between 115 and 230 volt. We have never seen a terminal with all these features for the incredibly low price of only $475. LIB-F50 40 lbs.

DIABLO

Word Processing Printer

$879



Now from the originator of the daisy wheel printer, the Diablo 620. Print speeds to 24 char/sec., user selectable bi-directional printing, superscripts, subscripts, graphics and more. Plus standard RS-232 interfacing. Communication speeds to 1200 baud with a 1500 character print buffer. Software programable absolute horizontal tabs makes report formatting easy. Over 20 different print wheels are currently available. The 620 automatically selects the print spacing for 10, 12, 15 char/inch print wheels. On site service available worldwide. DBL-620 50 lbs.

FREE

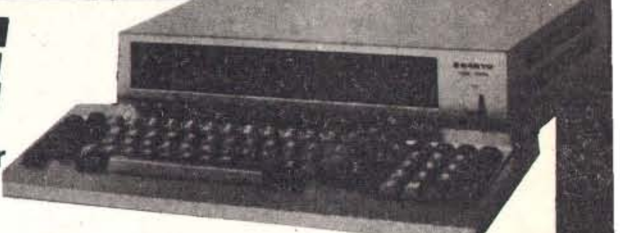
Your Choice

Second Drive or Monitor

SANYO

IBM COMPATIBLE

$995



Sanyo Electronics has just released the long awaited IBM/PC look-a-like, the MBC-550. This is a complete microcomputer that includes 128K/byte of memory, a 5¼" 160K/byte disk drive upgradeable to 320K/byte drives. Also includes both color composite and RGB graphics interface, low profile keyboard, and parallel printer port. Extensive software such as Sanyo Basic, disk utilities, Wordstar word processing software, Calcstar spread sheet & Easy Writer I. MS-DOS is supplied with the Sanyo computer. Most programs written for the IBM/PC will operate on the MBC-550.

Along with all this California Digital offers "FREE" your choice of either a second disk drive, or a high resolution green or amber screen monitor. All at the super low price of only $995.

We are currently experiencing an initial shortage of this computer. Please place your orders early. The MBC-550 will be shipped on a first ordered basis.

PRINTERS

$289 Star Gemini

MATRIX PRINTERS

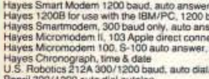
Star Gemini-10X 120 char/sec.	STR-G10X	289.00
Star Gemini-15X, 100 char./sec. 15" paper.	STR-G15X	419.00
Star Gemini Delta 10, 160 Char/sec	STR-D10	439.00
Star Coex 80FT friction & tractor	VST-C80FT	229.00
Toshiba P1350, 192 char/sec. letter quality	TOS-1350	1495.00
Okidata 82A serial & parallel 9½" paper	OKI-82A	379.00
Okidata 92A parallel interface, 160 char/sec.	OKI-92A	479.00
Okidata 83A & parallel 15" paper	OKI-83A	619.00
Okidata 84A & parallel 15" paper	OKI-84A	1019.00
Okidata 2350 (new) 350 char/sec	OKI-2350	1995.00
Epson FX80, 10" 160 char./sec. with graphtrax	EPS-FX80	529.00
Epson MX100 with graphtrax, 15" paper	EPS-MX100	589.00
NEC8023A parallel 9½" paper, graphics.	NEC-8023A	389.00
Anadex 9501A high speed with graphics	ADX-9501A	1099.00
Anadex 9620A 200 char/sec. par'l & serial.	ADX-9620A	1199.00
Quantex 7030 corespondence quality 180 char/sec.	QTX-7030	1595.00
Gorilla low cost dot matrix printer	PRO-7500	189.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	343.00
Prowriter II, parallel 15" paper, graphics	PRO-2P	689.00
Dataproducts B-600-3, band printer 600 LPM.	DPS-B600	6985.00
Printronix P300 high speed printer 300 lines per minute.	PTX-P300	4250.00
Printronix P600 ultra high speed 600 lines per minute.	PTX-P600	5795.00
Transtar 130P par'l, IBM/PC compatible	TNS-130P	629.00

WORD PROCESSING PRINTERS

NEC7710 55 char/second, serial interface	NEC-7710	1979.00
NEC7730 55 char/sec, par'l interface.	NEC-7730	1979.00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1799.00
NEC2050 designed for IBM/PC 20 char/sec. par'l.	NEC-2050	995.00
Silver Reed EXP500, 14 char/sec. par'l interface	SRD-EXP500	459.00
Silver Reed EXP550 17 Char/sec par'l interface.	SRD-EXP550	659.00
Diablo 630 40 char/sec. serial	DBL-630	1765.00
Diablo 620, proportional spacing, horz.& vert. tab. 20 cps.	DBL-620	879.00
Juki 6100, 18 char./sec. graphic mode.	JUK-6100	539.00
Brother HR1A daisy wheel, parallel interface	BTH-HR1P	695.00
Brother HR1A serial interface	BTH-HR1S	779.00
Starwriter F10 serial, 40 char/sec.	PRO-F10S	1125.00
Starwriter F10 parallel, 40 char/sec.	PRO-F10P	1125.00
Comrex CR1 word processing printer, serial intr.	CRX-CR1S	729.00
Comrex CR2, 5k buffer, proportional spacing, par'l.	CRX-CR2P	495.00

MONITORS

BMC 12A green phosphor 15 MHz. composit video.	BMC-12A	79.00
BMC 12" high resolution, 20MHz.	BMC-12EN	134.00
Zenith ZVM122 Amber Phosphor 12" 40/80 column switch.	ZTH-122	119.00
Zenith ZVM123 green phosphor 12" 40/80 column switch.	ZTH-Z123	105.00
NEC JB1201 green phosphor 18 MHz. composit video.	NEC-JB1201	169.00
NEC JB1260 commercial grade composit.	NEC-JB1260	129.00
USI Amber screen 12" composit monitor.	USI-12A	169.00
Motorola 23" open frame blk/white composit video.	MOT-BW23	159.00
Motorola 12" open frame requires horz sync. and power.	MOT-BW12	69.00
Conrac 9" open frame requires horz sync. & 12v. supply.	CON-BW9	59.00
COLOR		
BMC AU9191U Color composit video with sound	BMC-9191	249.00
BMC 9191M RGB designed for use with the IBM computer.	BMC-9191M	499.00
NEC JC1203DM, RGB color monitor	NEC-1203	699.00
NEC JC1201 color composit.	NEC-JC1201	339.00
Zenith ZVM134 RGB color suitable for IBM PC	ZTH-Z134	379.00
Comrex color composit with sound	COM-6500	329.00
Amdek Color 1, composit video	AMK-100	329.00



MODEMS

DIRECT CONNECT $69

Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	474.95
Hayes 1200B for use with the IBM/PC, 1200 baud.	HYS-1200B	449.00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279.00
Hayes Micromodem 100, S-100 auto answer, auto dial.	HYS-100	319.00
Hayes Chronograph, time & date	HYS-CHR232	199.00
U.S. Robotics 212A 300/1200 baud, auto dial/answer.	USR-212A	439.00
Penril 300/1200 auto dial,autolog	PEN-12AD	695.00
Universal Data 103LP, line power, answer & originate	UDS-103LP	169.00
Universal Data 103LPJ, Auto answer	UDS-103LPJ	219.00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	359.00
Novation 'J' Cat, direct connect, auto answer	NOV-JCAT	115.00
Novation Cat, acoustic connect	NOV-CAT	159.00
Novation SmartCat 103, auto answer, auto dial	NOV-SC103	219.00
Novation SmartCat 103/212, 1200 baud auto dial	NOV-SC212	529.00
Signalman Mark 1, direct connect with terminal cable.	SGL-MK1	69.00

TERMINALS

The Wyse 100 features die cast aluminum case, 102 key keyboard and non-glare 26 line green phosphor video display. Split screen both horizontal an vertical makes the WY-100 unusally user friendly. This unique terminal is perfect to enhance any business system.

$795

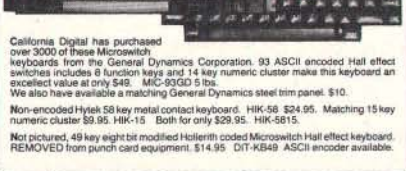
Freedom 50, split screen, detatchable keyboard	LIB-F50	475.00
Visual 50, detatchable, keyboard selectable settings.	VSL-50	619.00
Visual 50 Green screen	VSL-50G	650.00
Visual 330, emulator, 14 inch green phosphor.	VSL-33014G	925.00
Ampex Dialogue 125 green screen, two page, func. keys	APX-D125G	675.00
Ampex Dialouge 125 amber screen, two page, func. keys	APX-D125A	685.00
Wyse 50, 14" green phosphor	WYS-50	595.00
Wyse 100, horz & vert. split screen, metal enclosure	WYS-100	795.00
Wyse 300, Eight color display, split screen.	WYS-300	1159.00
Televideo 910 Plus, block mode	TVI-910P	575.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	759.00
Televideo 950, graphic char..split screen, 22 func.	TVI-950	950.00
Televideo 970, 14" green screen, 132 column, European	TVI-970	1095.00
Zenith 29 terminal, VT52 compatible, detatchable keyboard	ZTH-Z29	765.00

APPLE

$929

Apple II/e, 64K computer only	APL-2E	$989
Apple II/e starter kit, monitor, disk, 80 col. card.	APL-2ESK	1365
Advanced Busness Tech. 13 Key Pad	ABT-13B	109
Calif. Computer 7710A Async. Serial Interface	CCS-7710	125
Calif. Computer 7710B same but for modem	CCS-7710B	125
Calif. Computer 7114A 12K PROM module	CCS-7114	99
Calif. Computer 7720A parallel interface	CCS-7720	99
Calif. Computer 7724A Calandar/clock modual	CCS-7724	99
Calif. Computer 7729A Centronics interface	CCS-7729	99
Calif. Computer 7740A programmable timer	CCS-7740	99
California Digital 16K card for standard Apple II	CAL-A16	39
Hayes Micromodem for Apple II	HYS-MM2	279
Kensington Micro, System saver fan	KEN-SF1	75
Microsoft Softcard with CP/M; Z-80	MSF-SFTCD	239
Mountain Computer "The Clock"	MTN-TCLK	225
Mountain Computer AD/DA 16 input, 8bit	MTN-ADDA	269
Mountain Computer ROM Plus with keybd. filter	MTN-RMF	169
Mountain Computer ROM writer/socket socket	MTN-ROMW	139
Orange Micro "GRAPPLER" parallel interface	OMS-G2	135
Sorrento Valley 8" controller double side D/D.	SVA223	395
TEAC 5¼" disk drive for Apple II	TEA-A2	269
Vista Vision 80; 80 column card for std.Apple II	VSA-VIS80	289
Vista 8" disk controller double side D/D.	VSA-A800	389

ASCII KEYBOARD $49



California Digital has purchased over 3000 of these Microswitch keyboards from the General Dynamics Corporation. 93 ASCII encoded Hall effect switches includes 8 function keys and 14 key numeric cluster make this keyboard an excellect value at only $49. MIC-93GD 5 lbs.

We also have available a matching General Dynamics steel trim panel. $10.

Non-encoded Hytek 58 key metal contact keyboard. HIK-58 $24.95. Matching 15 key numeric cluster $9.95. HIK-15 Both for only $29.95. HIK-5815.

Not pictured, 49 key eight bit modified Hollerith coded Microswitch Hall effect keyboard. REMOVED from punch card equipment. $14.95 DIT-KB49 ASCII encoder available.

256 KILOBYTE MEMORY BOARD

$495

- 256 kilobytes of memory using 64K dynamic RAM.
- Over one megabyte of memory using the new 256K dynamic RAM chips.
- Error detection-trap capability.
- Individual 16K block can be relocated to any boundry within a megabyte of RAM.
- 24 bit addressing and phantom mode capability.

The California Digital 256K RAM board represents an outstanding value in S-100 memory technology. Priced slighty above earlier generation 64K dynamic ram boards it gives you these additional features. 256K of memory with parity. Parity error feature can be jumpered to any of the interrupt lines, a status port, ERROR LED, or IEEE-696 "ERROR signal. 24 or 16 bit addressing with memory management.

Proper operation with front panel equipped systems, DMA disk controllers, and IEEE-696 Temporary Buss Masters assured with an on the board M1 generator for memory refresh timing. CAS and RAS timing is controlled with tapped digital delay lines for proper operation over the entire operating temperature range.

The board is very recent in design using the National Semiconductor DP-8409 RAM Controller chip. Split termination networks are used on all address lines, CAS line, and RAS lines eliminating the last traces of ringing. The board uses two separate voltage regulators. One for the DRAMs and one for the interface logic increasing the noise immunity of the ram array. Typical power dissipation is 8 watts.

Documentation includes theory of operation, configuration guide, a schematic, and application notes on the use of the memory management options. CAL-256K 2 lhs.

S-100 BOARDS

16 BIT MICROPROCESSORS

Octagon dual CPU 8088/Z80, & controller.	OCT-88Z80	795.00
Godbout 8086/8087 microcomp. 16 bit.	GBT-8687	495.00
Godbout dual processor 8085/8088, 8/16.	GBT-8588	359.00

SINGLE BOARD COMPUTERS

Insight EQ-4, 128K, 4 serial "not S-100"	INS-EQ4	595.00
Advanced Digital, Floppy & 64K	AMD-Z80	750.00
Teletek System master, 765 floppy, 64K	TEL-SM1	895.00
Teletek FDC-1 single board, no memory	TEL-FDC1	675.00

8 BIT MICROPROCESSORS

Godbout Z80, 24 bit extended add.	GBT-Z80	250.00
California Computer Z80 microprocessor	CCS-2810	275.00
Tarbell Z80 with two RS232 ports	TAR-Z80	339.00

FLOPPY DISK CONTROLLERS

Godbout Disk 1, double density.	GBT-DSK1	395.00
California Computer 2422A with CPM	CCS-2422	339.00
Morrow Disk Jockey II with CPM 2.2	MDS-DJ2	350.00
Morrow Disk Jockey I with CPM, sgl. Den.	MDS-DJ1	225.00
Tarbell Electronics double density	TAR-DDC	419.00
Tarbell Electronics single density	TAR-SDC	279.00
Fulcrum DMA OmniDisk, I/O to hard disk	FCM-OD1	389.00

CPM OPERATING SYSTEM

Digital Research CP/M 3.0, 8" sgl. den.	DRC-CpM30	249.00
Godbout CPM 2.2 for Disk 1.	GBT-CpM22	159.00
Godbout CPM86 for 8088 and 8086	GBT-CpM85	265.00
Tarbell Electronics CPM 2.2	TAR-CpM22	159.00

HARD DISK CONTROLLERS

Octagon hard disk controller with E/C.	OCT-HD1	475.00
Godbout Disk 2, 8" & 14" hard disk	GBT-DSK2	569.00
Godbout Disk 3, for 5¼" Winchesters	GBT-DSK3	Nov.
Morrow Designs controller for 5¼" Win.	MDS-W506	495.00
Western Digital new WD-1001 (not S-100)	WDI-1001	495.00

EPROM BOARDS

Inner Access EPROM Bd. programs 27128	IAC-P100	465.00
Digital Research PROM board, 32K	DGR-P32	119.00

STATIC MEMORY BOARDS

Godbout Ram 16, 64K 16 bit data trans.	GBT-R16	459.00
Godbout Ram 17, 64K 8 bit 24 bitaddress	GBT-R17	359.00
Godbout Ram 21, 128K byte 8/16 transfer	GBT-R21	859.00
Fulcrum OmniRam 8/16 transfer bank	FCM-R816	395.00
California Computer 2116, 8 bit only	CCS-2116	249.00

DYNAMIC MEMORY BOARDS

California Digital 256K expand to 1 Meg.	CAL-D256	495.00
California Comp. 2066, 64K bank select	CCS-2066	295.00

INTERFACE BOARDS

Godbout Interfacer I, 2 serial ports	GBT-133A	239.00
Godbout Interfacer II, 1 serial 3 par'l ports	GBT-150A	269.00
Godbout Interfacer III, with 5 serial ports	GBT-135A	495.00
Godbout Interfacer III, with 8 serial ports	GBT-138A	585.00
Godbut Interfacer IV, 3 serial, 2 parallel	GBT-187A	329.00
California Computer 2710, 4 serial ports	CCS-2710	279.00
California Computer 2719, 2 serial, 2 par'l.	CCS-2719	295.00
California Computer 2720, 4 port par'l.	CCS-2720	219.00
California Computer 2830, 6 port serial	CCS-2830	429.00
Morrow Designs Multiboard, 3 S/2P	MDS-MTL1	319.00

SPECIAL FUNCTION BOARDS

Hayes S-100 Micromodem, 300 baud.	HYS-M100	325.00
QT Computer clock calendar, battery	QTC-CC100	139.00
Godbout System support board, 4K EPROM	GBT-SYS1	350.00
Godbout System support board, 9511 math	GBT-S9511	539.00
Dual Systems, 4 channel 12 bit D/A conv.	DSC-AOM12	519.00
Dual System 12 bit resolution, 32 ch. A/D	DSC-AIM12	629.00
Mullins Opto-Isolator, controls 8 ch.	MUL-ICB10	179.00
Mullins extender board with logic & probe	MUL-TB4	79.00
I/O Technology wire wrap prototype	IOT-W100	49.00
Artec Electronics wire wrap prototype	ART-WW100	25.00
Artec Electronics general purpose solder	ART-GP100	25.00

MAINFRAMES & MOTHER BOARDS

Eclipse Data, stainless, 22 slot	EDP-100	595.00
Godbout Enclosure 2, 20 slots	GBT-MF20	675.00
California Computer 2200, 12 slot	CCS-2200	479.00
California Digital 18 slot mother board	CAL-MB18	35.00
Godbout 12 slot mother board assembled	GBT-MB12	149.00

CP/M SOFTWARE

AdaSoft CP/M	ADA-445C	395.00
D-Base II	ASH-015C	429.00
Wordstar	MPR-187C	309.00
Mailmerge	MPR-392C	169.00
Spellstar	MPR-429C	169.00
Multiplan	MSF-483C	189.00
Macro 80	MSF-187C	139.00
Supersoft	MPR-309C	149.00
MAC	DGR-401C	85.00
CP/M 3.0	DGR-410C	249.00
Despool	DGR-367C	45.00
Pascal Plus	DGR-004C	429.00
CP/M 86	DGR-186C	239.00
MP/M II	DGR-208C	379.00

Additional Software available for Apple, IBM/PC and Atari. Please telephone for price and availability.

VISA

master charge

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(213) 643-9001

DISKETTES For IBM PC

High qualtiy double-sided, double-density diskettes, certified to be absolutely error free. Box of ten, warranteed for one year

MMD-5220104	*With FREE! plastic case*	$24.95
MMD-5220101	*Verbatium Datalife*	$34.95

ACCESSORIES for your IBM PC

QUADBOARD I—QUADRAM

Up to 256K RAM, serial port, parallel printer port, clock calendar, RAM disk, and printer spooler software

MEX-41000A	*Quadboard w/o RAM*	$214.95
MEX-41064A	*64K Quadboard*	$275.00
MEX-41256A	*256K Quadboard*	$399.95

QUADBOARD II—QUADRAM

Two serial ports, clock/calendar, memory expansion, and Quadmaster software

MEM-40064A	*Quadboard II, 64K*	$275.00
MEX-40256A	*Quadboard, 256K*	$399.00

QUADLINK—QUADRAM

Allows IBM PC to run Apple software, includes interface card and software to allow your IBM PC to run both Apple DOS and PC DOS

CPX-50500A	*Quadlink*	$485.00

SIX PAK PLUS—AST

Up to 384K RAM, clock calendar with battery back-up, serial port, parallel printer port, optional game port. Super drive and super spool software included FREE!

MEX-38064A	*64K, C.S.P*	$269.95
MEX-38256A	*256K, C.S.P*	$489.95
For Game Port Option Add		$39.95

MEGA PLUS—AST

Up to 512K RAM, clock calendar with battery back-up, 2 serial ports, parallel printer port, game port. Super drive and superspool software included FREE!

MEX-51064A	*64K, C.1 serial*	$269.95
MEX-51000S	*Second serial port option*	$39.95
MEX-51000P	*Printer port option*	$39.95
MEX-51000G	*Game port option*	$39.95
For Each Additional 64K RAM Add		$49.95

COMBO PLUS II—AST

Up to 256K RAM, clock with battery back-up, serial port, parallel port, superspool software included FREE!

MEX-25064A	*64K,C,S,P*	$269.95
MEX-25256A	*256K,C,S,P*	$419.95

I/O PLUS II—AST

Up to 2 serial ports, parallel printer port, game port, clock calendar with battery back-up. Super drive and superspool software included FREE!

IOI-7500A	*Clock & 1 serial port*	$129.95
IOI-7500P	*Printer port option*	$39.95
IOI-7500S	*Second serial port option*	$39.95
IOI-7500G	*Game port option*	$39.95

KEYTRONICS KEYBOARD

Similar to the IBM PC keyboard, but with all the keys in the right places for word processing

KBE-45100	*Keytronics/IBM*	$199.95

320K DISK DRIVES

Tandon TM-100-2 double-sided, double-density 320K disk drive. Original equipment drive on IBM PC

MSM-551002	*Full size Tandon*	$224.95
MSM-991004	*Half-height 320K drive*	$199.95
MSM-660551	*Teac Half-height*	$239.95

HARD DISK For IBM PC

Hard disk with controller, software, and P/S

MSH-990205	*5MB system*	$1395.00
MSH-990210	*10MB system*	$1699.00
MSH-990215	*15MB system*	$2199.00

SYSTEM CARD—MICROSOFT

From the authors of MS-DOS—up to 256K RAM, serial port, parallel printer port, clock calendar, plus RAM drive disk emulation, print spooler, time utilities, and terminal emulation software, DOS 1.1 or 2.0 compatible

MEX-16064A	*64K system card*	$279.95
MEX-16256A	*256K system card*	$429.95

OKIDATA IBM KIT

Okidata's new plug-n-play ROMs for Oki 82, 83, 84, 92, and 93 printers are fully IBM PC compatible! 412 ASCII characters, full graphics, complete Epson emulation, and near letter quality printing not available with Epson

PRA-43086	*Plug-n-play for 92*	$49.95
PRA-43087	*Plug-n-play for 93*	$49.95
WCA-2536A	*IBM PC to Oki or Epson cable*	$32.95
PRA-43084	*Plug-n-play for 82*	$39.95
PRA-43085	*Plug-n-play for 83*	$39.95
PRA-43089	*Plug-n-play for 84*	$89.95

NEC 3550 LETTER QUALITY

Only full IBM PC compatible letter qulaity printer available—why settle for less!

PRD-35501	*NEC 3550 printer*	$1799.95

64K RAM UPGRADE For IBM PC

High speed RAM upgrade kit with parity (error detection) and one year warranty

MEX-64100K	*64K kit for IBM PC*	$49.95

HI-RES COLOR MONITORS

Only the best Quadchrome or Princeton HX-12, 690 x 480 resolution, 16 brilliant colors, special .31mm dot pitch tube, includes FREE! cable

VDC-241301	*Quadram Quadchrome*	$549.95
VDC-241401	*Princeton Graphics HX-12*	$529.95

AMDEK MONITORS

Full line of high quality monochrome and color video monitors

VDM-801270	*Video 310 Amber (IBM)*	$159.95
VDC-801320	*Color II (RGB)*	$429.95
VDC-801330	*Color III (RGB)*	$399.95
VDC-801340	*Color IV (Analog RGB)*	$775.00

HERCULES GRAPHIC CARD

Two pages of ultra-high resolution text and graphics. 720 x 348, compatible with Lotus 123, Visicalc, dBASE II, etc. Includes parallel printer port

IOV-5010A	*Hercules graphic card*	$359.95

QUADCOLOR I & QUADCOLOR II

Quadcolor I delivers standard IBM PC color and graphics, add Quadcolor II and hi-resolution (640 x 200) color graphics are possible

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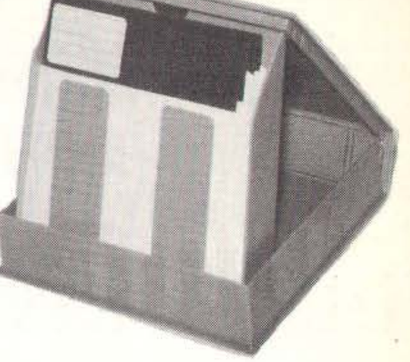

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12" MONITORS

For complete specifications, see page 24 of our New '83/'84 Engineering Selection Guide.

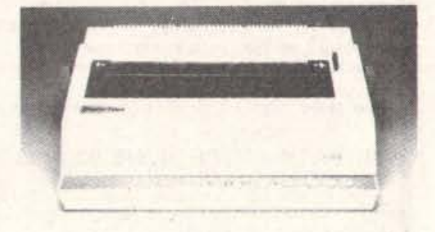
Part Number	Description	List Price	SALE Price
BATAXKG12N	Green Screen (Sh. Wt. 18 lbs.)	$179.00	**$119.00**
BATAXKG12NUY	Amber Screen (Sh. Wt. 18 lbs.)	$189.00	**$129.00**

SAVE ON RGB MONITORS, TOO!

Part Number	Description	List Price	SALE Price
BATAXRGB1	Medium Resolution (30 lbs.)	$399.00	**$329.00**
BATAXRGB3	Super-High Resolution (30 lbs.)	$699.00	**$569.00**
BATAXRGB420	IBM™ Styling Hi-Res RGB (30 lbs.)	$699.00	**$569.00**

NEW! star micronics·inc

POWER TYPE 18 CPS DAISYWHEEL PRINTER



$499.00

- Parallel and Serial Interface • Four Print Sizes
- Wheels and Ribbons are QUME Compatible
- Selector Switches for Columns, Line Spacing and Paper Length

BASTRPOWERTYPE	Daisywheel Printer (Sh. wt. 22 lbs.)	***$499.00***

MANNESMANN TALLY

Letter Quality Dot Matrix Printer

For complete specifications, see page 41 of our New '83/'84 Engineering Selection Guide

- 160 cps • 40 cps (Letter Quality)
- Serial & Parallel Interface • Double wide characters
- Tractor and friction feed • "Bullet-Proof" cast frame with metal cabinet

Not the Cheapest — Just the Best Dollar Value!

BATALMT160L	80 column / 160 cps (21 lbs.)	**$589.00**
BATALMT180L	132 column / 160 cps (28 lbs.)	**$829.00**
BATALMTRIB160	Replacement Ribbon for MT160L (1 lb.)	**$ 15.75**
BATALMTRIB180	Replacement Ribbon for MT180L (1 lb.)	**$ 17.80**

CompuPro The World's Largest Dealer of S-100 Boards SDSystems

CPU BOARDS

		List Price	Sale Price
BAGBT51068	CPU 68K A&T 8MHz	$ 695.00	**$ 595.00**
BAGBT51568	CPU 68K CSC 10MHz	$ 850.00	**$ 765.00**
BAGBT51086	Co-Processor w/8086 only A&T	$ 750.00	**$ 675.00**
BAGBT51586	Co-Processor w/8086 only CSC	$ 850.00	**$ 765.00**
BAGBT51067	CPU 8086/8087 A&T	$1050.00	**$ 939.00**
BAGBT51567	CPU 8086/8087 CSC	$1150.00	**$1065.00**
BAGBT51080	CPU 8085/88 A&T	$ 495.00	**$ 389.00**
BAGBT51580	CPU 8085/88 CSC	$ 595.00	**$ 497.87**
BAGBT51060	3/6MHz CPU-Z A&T	$ 325.00	**$ 279.00**
BAGBT51560	3/6MHz CPU-Z CSC	$ 425.00	**$ 347.87**

DISK CONTROLLER BOARDS

BAPDB171ACPM	DISK 1 (A&T) w/CP/M® 2.2	$670.00	**$489.00**
	When purchased with two 8" disk drives:		**$450.00**
BAGBT54018	DISK 1 Floppy controller (A&T)	$495.00	**$425.00**
BAGBT41000	CP/M® 2.2 for Z80/8085 w/manuals & BIOS, 8" S/D Disk		**$148.95**
BAGBT41050	CP/M-86® for CPU 8085/88 & CPU 8086/87 CPUs w/manuals, BIOS 8" S/D Disk		**$249.00**
BAGBT54025	DISK 2 8" hard disk controller w/CP/M® 2.2 (A&T)	$795.00	**$725.00**
BAGBT54030	DISK 3 ST-506 type 5¼" hard disk controller w/CP/M-80® & CP/M-86® (A&T)	$795.00	**$725.00**

I/O BOARDS

BAGBT56010	System Support 1 Multifunction I/O (A&T)	$450.00	**$375.00**
BAGBT56010/56531	SS1 w/8231 Math Chip A&T	$645.00	**$570.00**
BAGBT56010/56320	SS1 w/8232 Math Chip A&T	$645.00	**$570.00**
BAGBT53030	Interfacer 3 - 8 port serial (A&T)	$699.00	**$599.00**
BAGBT53040	interfacer 4 - 3 Serial, 1 Centronics Parallel, 1 Parallel (A&T)	$450.00	**$389.00**

8/16 BIT MEMORY BOARDS

BAGBT52016	RAM 16 12MHz 32K Static A&T	$ 550.00	**$ 495.00**
BAGBT52021	RAM 21 12 MHz 128K Static A&T	$ 995.00	**$ 895.00**
BAGBT52022	RAM 22 12MHz 256K Static A&T	$1750.00	**$1549.00**
BAGBT52012	M-Drive/H 512K RAM Disk A&T	$1475.00	**$1195.00**

MAINFRAMES

BAGBT1200	20 Slot Desk Top (A&T)	$925.00	**$795.00**
BAGBT1250	20 Slot Rack Mount (A&T)	$975.00	**$850.00**

For more CompuPro Specifications see pages 2-33 of our New Catalog Vector

Manufactured by Vector Electronic Co. under license from CompuPro

BAVCT8800GFB	Interfacer 1, 2-Serial (A&T)	$295.00	**$219.00**
BAVCT8800GF2B	Interfacer 2, 3-Par., 1-Ser (A&T)	$325.00	**$239.00**
BAVCT8800GR17B	RAM 17 64K 10MHz Static RAM (A&T)	$450.00	**$389.00**

A SYNTECH COMPANY

		List Price	Sale Price
BASDS38095	SBC-300 4MHz Z80A CPU A&T	$ 741.00	**$ 619.00**
BASDS38092	SBC-300 6MHz Z80B CPU A&T	$ 825.00	**$ 689.00**
BASDS38007	Z80 Starter System A&T	$ 450.00	**$ 399.00**
BASDS38088	ExpandoRAM IV 256K A&T	$1145.00	**$ 975.00**
BASDS38089	ExpandoRAM IV 256K w/EDC A&T	$1990.00	**$1675.00**
BASDS38097	ExpandoRAM III/696 256K	$ 825.00	**$ 749.00**
BASDS38076	PROM-100 w/software A&T	$ 285.00	**$ 219.00**
BASDS38082	RAM Disk 256K A&T	$ 875.00	**$ 775.00**
BASDS38081	ROM Disc 128K A&T	$ 350.00	**$ 319.00**
BASDS38096	I/O-8 4-Port Async Ser. A&T	$ 600.00	**$ 549.00**
BASDS38093	I/O-8 8-Port Async Ser. A&T	$ 695.00	**$ 589.00**
BASDS38094	I/O-8 4 Sync, 4 Async, 8-Port Serial I/O A&T	$ 795.00	**$ 699.00**
BASDS38099	Versafloppy III Floppy & ST-506 Hard Disk Controller	$ 895.00	**$ 759.00**
BAPDBVF339145*	w/5¼" unbanked CP/M® 3.0	$1083.00	**$ 888.00**
BAPDBVF339146*	w/8" unbanked CP/M® 3.0	$1083.00	**$ 888.00**
BAPDBVF339147*	w/5¼" banked CP/M® 3.0	$1083.00	**$ 888.00**
BAPDBVF339148*	w/8" banked CP/M® 3.0	$1083.00	**$ 888.00**
BASDS38093	Versafloppy II/696 (A&T)	$ 400.00	**$ 344.00**
BAPDBVF239141*	w/5¼" unbanked CP/M® 3.0	$ 588.00	**$ 424.00**
BAPDBVF239142*	w/8" unbanked CP/M® 3.0	$ 588.00	**$ 424.00**
BAPDBVF239143*	w/5¼" banked CP/M® 3.0	$ 588.00	**$ 424.00**
BAPDBVF239144*	w/8" banked CP/M® 3.0	$ 588.00	**$ 424.00**

*CP/M-Plus™ (3.0) configured for the SBC-300

See Complete Specifications on Pages 12-25 Of Our '83/'84 Engineering Selection Guide

octagon

BOARD LEVEL PRODUCT

BAOCTCPU816	8/16 Bit SBC (A&T)	$ 895.00	**$ 795.00**
BAOCT8087NDP	8087 for CPU 8/16		**$ 300.00**
BAOCTCPM86	CP/M-86®		**$ 150.00**
BAOCTCONCPM86	Concurrent CP/M-86®		**$ 195.00**
BAOCTMPM86	MP/M-86®		**$ 495.00**
BAOCTHDC	ST-506 Hard Disc Controller	$ 595.00	**$ 525.00**
BAOCTHDSUB19	19.2Mb Hard Disc Subsystem	$2295.00	**$ 195.00**
BAOCTS256TOD	256K Static RAM (A&T)	$1850.00	**$1719.00**
BAOCTD512K	512K Dynamic RAM (A&T)	$1450.00	**$1345.00**

See Specifications on Pages 12-27 Of Our '83/'84 Engineering Selection Guide

COMPLETE OCTAGON 8/16™ SYSTEMS

BAOCT816SMPM	w/256K Static RAM & MP/M-86™	**$7350.00**
BAOCT816SCPM	w/256K Static RAM & Concurrent CP/M-86	**$7350.00**
BAOCT816DMPM	w/512K Dynamic RAM & MP/M-86	**$7350.00**
BAOCT816DCPM	w/512K Dynamic RAM & Concurrent CP/M-86	**$7350.00**

See Complete Specifications on Page 5 Of Our New '83/'84 Engineering Selection Guide

MACROTECH International Corp.

S-100 Boards

See Page 16 Of Our New '83/'84 Engineering Selection Guide for Complete Specifications

Ordering Information: The 256K and 384K versions include the fully socketed Host card. The 512K and larger versions also include the fully socketed "piggy-back" card.

		List Price	Sale Price
BAMACMAX256	256K Dynamic RAM (A&T)	$1125.00	**$1165.00**
BAMACMAX384	384 Dynamic RAM (A&T)	$1467.00	**$1395.00**
BAMACMAX512	512K Dynamic RAM (A&T)	$1880.00	**$1795.00**
BAMACMAXM	1 MEG Dynamic RAM (A&T)	$2449.00	**$2325.00**
BAMACMAXTM	MAX Technical Manual		**$ 15.00**
BAMACMAXVDSK	MAX Virtual Disk Software supplies on 8" S/D Disk		**$ 25.00**
BAMACM3	Memory Mapping Option		**$ 91.00**

Attention CompuPro CPU 8085/88 Users: You must order the CPU modification hardware to insure complete compatibility.

BAMACGBTMOD	Hardware modification for CompuPro CPU 8085/88	**$ 10.00**

DISK DRIVES

5¼" Hard Disk

		SALE PRICE
BANCP1302	Micropolis 20.4/25.9 Mb (12 lbs.)	**$1465.00**
BAMCP1303	Micropolis 33.9/43.2 Mb (12 lbs.)	**$1875.00**
BAMCP1304	Micropolis 40.8/51.9 Mb (12 lbs.)	**$2195.00**
BATNDTM501	Tandon 6 Mb (9 lbs.)	**$ 749.00**
BATNDTM502	Tandon 12 Mb (9 lbs.)	**$ 895.00**
BATNDTM503	Tandon 19 Mb (9 lbs.)	**$1049.00**
BAIIIHD5002	Dual Hard Disk Enclosure	**$ 395.00**

5¼" Floppy Disk Drives

BAMPI51*	MPI Full Height SS 48TPI (5 lbs.)	**$200.00**
BAMPI52*	MPI Full Height DS 48TPI (5 lbs.)	**$270.00**
BAMPI91*	MPI Full Height SS 96TPI (5 lbs.)	**$275.00**
BAMPI92*	MPI Full Height DS 96TPI (5 lbs.)	**$400.00**
BAMPI501	MPI ½-Height SS 48TPI (4 lbs.)	**$260.00**
BAMPI502	MPI ½-Height DS 48TPI (4 lbs.)	**$300.00**
BAMPI901	MPI ½-Height SS 96TPI (4 lbs.)	**$300.00**
BAMPI902	MPI ½-Height DS 96TPI (4 lbs.)	**$355.00**
BATNDTM1001	TAndon Full Height SS 48TPI	**$225.00**
BATNDTM1002	Tandon Full Height DS 48TPI	**$260.00**
BATNDTM1014	Tandon Full Height DS 96TPI	**$390.00**

*Replace with **M** for MPI Door, or **S** for Shugart SA400 Type Door

8" Floppy Disk Drives

BASHU801R	Shugart Full Height SS (18 lbs.)	**$369.00**
BASHU851R	Shugart Full Height DS (18 lbs.)	**$525.00**
BAQMEDT8	Qume Full Height DS (18 lbs.)	**$475.00**
BAMITM289463B	Mitsubishi Full Height DS (18 lbs.)	**$380.00**
BAMPI415	MPI Full Height SS (11 lbs.)	**$380.00**
BAMPI425	MPI Full Height DS (11 lbs.)	**$460.00**
BAMPI41D	MPI Dual ½-Height SS (22 lbs.)	**$760.00**
BAMPI42D	MPI Dual ½-Height DS (22 lbs.)	**$830.00**
BAMPI41M	MPI ½-Height SS (9 lbs.)	**$380.00**
BAMPI42M	MPI ½-Height DS (9 lbs.)	**$460.00**
BATNDTM8481	Tandon ½-Height SS (9 lbs.)	**$395.00**
BATNDTM8482	Tandon ½-Height DS (9 lbs.)	**$495.00**

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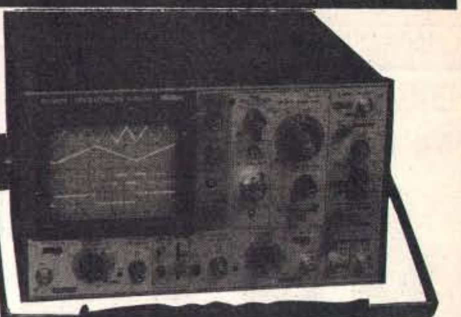
ONE IN PRICE — NUMBER ONE IN SERVICE

HITACHI Hitachi Denshi, Ltd. DUAL TRACE SCOPES



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NEW LOWER PRICES!

FOR COMPLETE SPECIFICATIONS ON HITACHI OSCILLOSCOPES, SEE PAGES 82 & 83 IN OUR '83/'84 ENGINEERING SELECTION GUIDE

20MHz Low Profile	40MHz with Delay Line	60MHz with Trigger View	100MHz Delayed Sweep/ Quad Trace
BAHITV222 List Price: $695.00	**BAHITV422** List Price: $895.00	**BAHITV650F** List Price: $1195.00	**BAHITV1050F** List Price: $1595.00
SALE PRICE: **$595.00**	***SALE PRICE:*** **$749.00**	***SALE PRICE:*** **$995.00**	***SALE PRICE:*** **$1395.00**
(Shipping Weight: 17 lbs.)	(Shipping Weight: 17 lbs.)	(Shipping Weight: 31 lbs.)	(Shipping Weight: 31 lbs.)

A UNIT OF GENERAL SIGNAL GS

SOLA

Uninterruptable Power System

For more specifications, see page 94 of our New '83/'84 Engineering Selection Guide.

A mini UPS goes one step further than aminicomputer regulator. It provides the same voltage, noise, and brownout protection plus maintains power to keep equipment running smoothly during a blackout. When a power failure occurs, the internal maintenance free battery continues powering the inverter without the use of any switching devices. This provides uninterrupted, conditioned AC power to the critical load.

PORTABLE 120VAC 60Hz UNINTERRUPTABLE POWER SYSTEMS

Part Number	Mx. Out. VA rating/ Time	Dimensions H x W x D	Approx. Shipping Weight	PRICE List	SALE
BASLA260050400301	400/20min	12x19x11	95lbs.	$1617.00	**$1406.00**
BASLA260050750300	750/10min	12x19x11	125lbs.	$1722.00	**$1497.00**
BASLA401751BA0	Add-on battery pack (120 lbs.)			$1014.00	**$882.00**

The Micro/Mini Computer Ultra Isolated Regulator provides instantaneous voltage regulation, and ultra isolation from both transverse and common mode noise for any type of load. It is particulary applicable in systems involving mini or microcomputers, POS equipment, industrial control equipment, or data terminals.

MINICOMPUTER REGULATORS

With Line Cord

BASLA6313070	70	12x 6x 6	10lbs.	$ 192.05	**$ 159.00**
BASLA6313114	140	12x 6x 6	18lbs.	$ 251.85	**$ 209.00**
BASLA6313125	250	14x 8x 8	31lbs.	$ 300.15	**$ 249.00**
BASLA6313150	500	17x 9x 9	47lbs.	$ 416.30	**$349.00**
BASLA6313175	750	17x 9x 9	60lbs.	$ 530.15	**$ 439.00**
BASLA6313210	1000	17x 9x 9	75lbs.	$ 614.10	**$ 519.00**
BASLA6313220 †	2000	17x11x11	108lbs.	$1044.20	**$ 889.00**

† Unit is supplied with 30 amp twist type plug and receptacles.

IPD AC SURGE PROTECTORS FOR YOUR COMPUTER

THE LEMON™ SOURS SURGES

Part Number	Description	List Price	Our Price
BAEPDLEMON	6 outlet wall mount	$59.95	**$44.95**
BAEPDLIME	6 outlet 4½' cord w/power switch	$89.50	**$69.95**

(Shipping weight on above items 4 lbs each)

EMI-RFI FILTERED AC SURGE PROTECTOR

BAEPDORANGE	6 outlet 4½' cord w/power switch	$139.95	**$104.95**
BAEPDPEACH	3 outlet wall mount	$ 97.50	**$ 74.95**

(Shipping weight on above items 4 lbs each)

AC POWER LINE MONITOR / SURGE PROTECTOR

BAEPDHAWK (Sh. Wt. 6 lbs.) $195.00 **$149.00**

SPECIAL PURCHASE DISKETTES!!

TDK 8" DOUBLE DENSITY

BATDKF1S

SINGLE SIDED **$19.95** PER BOX OF 10

BATDKF2D

DOUBLE SIDED **$29.95** PER BOX OF 10

ATARI & COMMODORE PLUG AND RUN PRINTERS!

Complete with Built-In Interface Cables!

AXIOM

1 Year Warranty!

BAAXMAT100A	For ATARI (Sh. Wt. 11 lbs.)	**$229**
BAAXMCD100A	For COMMODORE (11 lbs.)	**$229**
BAAXMGP100A	30 cps; 80 col. dot matrix printer (11 lbs.) Parallel Interface	**$199.00**

1200 BAUD MODEM SALE

For more details on Modems, see pages 38 & 39 of our New Catalog.

U.S. ROBOTICS INC — AUTO DIAL/ AUTO ANSWER

FREE SOFTWARE!

Part Number	Description	List Price	SALE Price
BAPDBPASSTEL8	Password Modem w/Communication Software 8" CP/M™	$528.00	**$398.00**
BAPDBPASSTEL5	Password Modem w/Communication Software 5¼" Apple	$528.00	**$398.00**
BAPDBASIALTEL8	Auto Dial 212A Modem w/Communication Software 8" CP/M*	$678.00	**$495.00**
BAPDBADIALTEL5	Auto Dial 212A Modem w/Communication software 5¼" Apple	$678.00	**$495.00**
BAPDB5100TEL8	S-10 Modem Card w operating software on 8" CP/M* diskette	$528.00	**$398.00**

D.C. HAYES

Part Number	Description	List Price	SALE Price
BADCH0400P	1200 Baud Smartmodem	$695.00	**$514.95**
BADCH0200P	300 Baud Smartmodem	$279.00	**$229.00**
BADCH0300P	Chronograph	$249.00	**$199.00**
BADCH0100P	MicroModem 100	$399.00	**$349.00**
BADCH000P	MicroModem II	$379.00	**$299.00**
BADCH1200B	IBM-PC™ Modem card	$599.00	**$499.00**

RIXON

1200 Baud Direct Connect w/10 Number Memory

BARIXR212A	1200 Baud Stand Alone unit	$495.00	**$449.00**
BARIXPC212A	1200 IBM PC™ modem (2 lbs.)	$495.00	**$449.00**
BARIXPCCOM1	IBM PC™ Modem Software (1 lb.)		**$ 89.00**
BAPDBRIXIBM	IBM Modem & Software Together (3 lbs.)		**$539.00**

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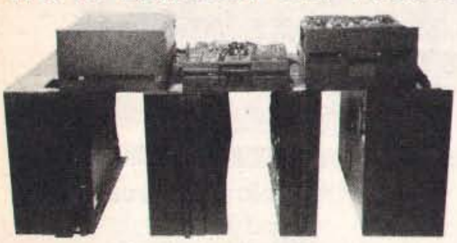

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8" Shugart 801R SS/DD — The Industry Standard	$355.00
8" Shugart 851R Double Sided 1.2 Meg — The Old Reliable	457.00
8" Qume Datatrak-8 DS/DD "THE BEST" of the floppys	479.00
8" Mitsubishi Full Height Double Sided 1 Year Parts + Labor	445.00
8" Mitsubishi Thinline DS/DD 1 Year P+L Direct Drive	465.00
8" Tandon 848-1 Slimline SS/DD 600K BYTES D.C. Motor	355.00
8" Tandon 848-2 Slimline Double Sided 1.2 Meg. D.C. Motor	475.00
8" Siemens 100-8 SS/DD ON SALE NOW!!! But How Long?	**169.00**
5¼" Mitsubishi Full height 96T.P.I DS/DD 750K M4852	295.00
5¼" Mistubishi Slimline 96T.P.I. DS/DD 750K M4853	315.00
5¼" Qume 142 Slimline DS/DD	375.00
5¼" Tandon TM-100-2 I.B.M. PC Add-on! DS/DD 48 T.P.I.	259.00
5¼" Tandon TM 100-4 DS/DD 96T.P.I. 750K	369.00

★ WINCHESTER HARD DISKS ★

SPECIALS

5¼" Miniscribe Hard Disk

***5 Meg $589 *10 Meg $749**

8" Quantum 20* Megabyte Winchester — Two Platters	1895.00
8" Quantum 40* Meg Four Platter — Most Popular	2395.00
8" Quantum 85* Megabyte — Special Order on this Monster!	2895.00
8" IOMEGA 10- Meg* Removeable Disk Drive with SCSI Controlled Interface Board. Runs up to four drives	1895.00
8" IOMEGA 10 Meg* Cartridge Drive — No Control Interface	895.00
8" 10 Meg* Removeable Cartridge Media #M-2000-51	50.00

★LAST MINUTE SPECIAL!!! Buy any Winchester hard disk drive above and get a Western Digital hard disk interface board AT COST! .... *ONLY* **295.00!**

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New CCS2066 64K Dynamic Memory

• 65,536 bytes of Dynamic RAM • Z-80/8080, S-100 compatible • Port bank/16 levels of 64K = system memory of 1024K • Independently addressed in 16K blocks • 200ns access and data lines • Hysteresis drivers and receivers for high noise immunity and minimal bus loading effects. Part #B-5000-50 .... **ONLY $299.00**

YEAR END SYSTEM SALE

- 2300A Mainframe
- 2066 64K Memory
- 2810 Z-80A CPU
- All AC/DC & Data Cables
- 2422 Disk Controller
- CP/M Operating System
- 2719 2-Port RS-232 Serial
- 8-bit Parallel I/O

A powerful package at ONLY $1495.00

CCS CALSTAR SYSTEM

Now available and with FREE SOFTWARE: • Perfect Writer • Perfect Calc • Perfect Speller and • Perfect Filer.

This powerful single box system includes: • Z-80 with 128K of RAM expandable to 256K • A networking interface • SASI hard disk interface to add-on a Winchester • CP/M 3.0 operating system • One parallel and two serial ports • Reads and writes the IBM 3740 format (compatible with **XOR**) AND • Two double-sided double-density 8" floppy drives for 2.4 Megabytes of formatted storage AND • Will run two or more 8" or 5¼" floppys. Part #S-1500-05

ON SALE NOW

Regular ~~$3295.00~~ — Our Price Only $2695.00

SPECIAL ONLY $450.00

Limit 5 per customer

XOR-500 DAISYWHEEL PRINTER

A letter-quality daisy-wheel printer at an unheard of wholesale price. This 20 cps workhorse features a daisy-wheel compatible with QUME's products. Full 132 column format with 256 character buffer, serial AND parallel interfacing (standard), 8 level automatic impression control — original and 3 copies. The **$450.00** price is not a misprint. High reliability and quality performance sums-up the **XOR-500 Daisy-wheel Printer.**

XOR-500 TERMINAL

SLASHED!

Cut another $50

SALE!

Only $445.00

That's right! A 700.00 terminal for $445.00, a special deal for our customers.

Features: ★Screen tilt ★Detached keyboard ★9 cursor control keys ★5 function keys ★7 screen attributes ★25th status line ★50-19.2 Kbaud ★Column plus field tab ★AND MORE ★All these features with a full 6 month warranty makes this terminal the best buy on the market.

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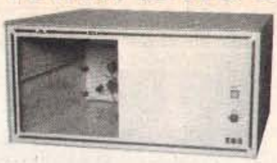

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ON THE ORIGINAL S-100 MOD

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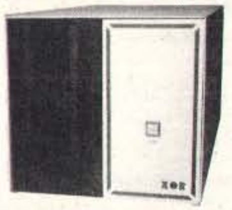

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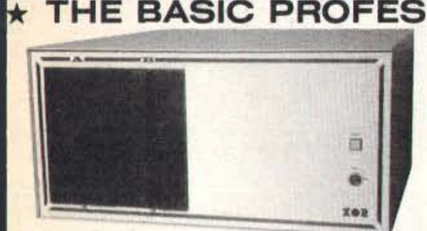

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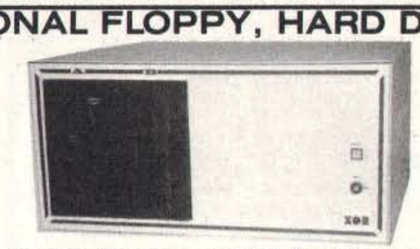
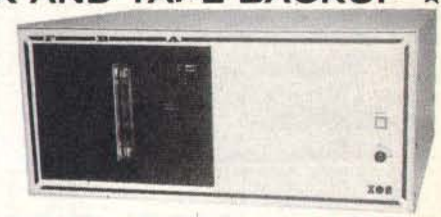


20 Meg Winchester w/2.4 Meg Floppys

For the serious professional this system features the famous S-100-12 cabinet with XOR's S1-MOD 12-slot motherboard. The Quantum hard disk has two 10 Meg platters (A: and B:). One platter can be "backed-up" on another. 2/DS/DD 1.2 floppys are used for software entry, copies, and back-up. One year parts and labor. #S-1000-63 **$5275.00**



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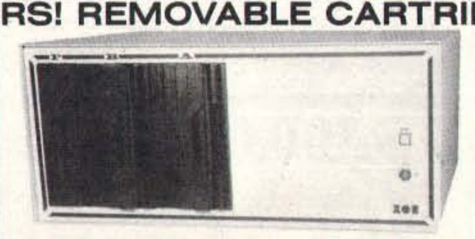

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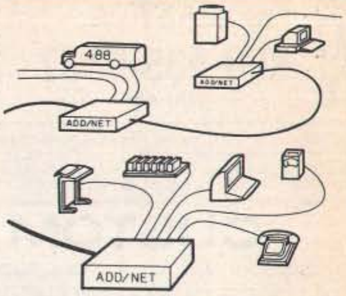

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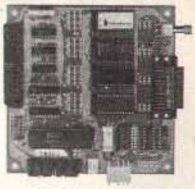

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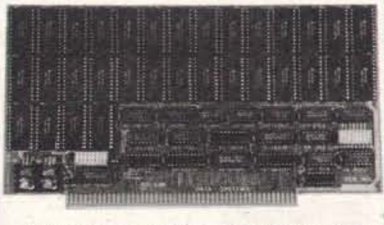

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September 9, 1983

Becky
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Becky:

Thank you so much for the speedy reshipment of the order we placed. Our experience with JDR has been excellent, and the manner in which you handled this situation will reinforce that impression.

Thanks,

Howard Katz

---

25 April 1983

JDR Microdevices, Inc.
Office of the President
1224 S. Bascom Avenue
San Jose, CA 95128

Dear Sir:

I am writing this letter to highly commend the service afforded me by the employees of JDR Microdevices. Not only do I find your pricing policy to be very superior to that of your competitors, but the service given each customer by far exceeds any that I have received from other component distributors. I have found that any order or problem has been handled in the most courteous and expeditious manner.

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Thank you very much.

Sincerely,

David Lovelace

JDR Microdevices
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San Jose, CA 95128

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*NOTE: Items marked with asterisk indicate features most favorable to my firm.

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Sincerely,

Sebastian Sullivan
Supervising Engineer
Computer Research Technology

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Dear Reyna:

Enclosed please find the 4164-200 RAM chip as per our phone conversation on 08/24/83.

I want to thank you for your cooperation and swift action.... This is usually a rare quality not found in most of the mail order firms we've dealt with in the past. I can assure you that you will be at the top of our list whenever we require any of your fine products.

Thank you,

Patrick Grace
President
TECHNI-SOFT

Dear JDR:

...time for something that I don't normally do. That is congratulate JDR for the great service I have received in the past. I have ordered quite a number of times this past year and am continually impressed with the friendly sales staff, the speed at which the order arrives and the accuracy of the orders. I do quite a bit of business through the mail and JDR has been the best firm that I have dealt with. So, please keep up the good work. My associates and I really appreciate it!

Thanx a bunch,

Gordon Scott Mather

JDR Microdevices

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2112	256 x 4 (450ns)	2.99
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2114-25	1024 x 4 (250ns)	8/10.95
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LP = Low Power Qstat = Quasi-Static

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2732-250	4096 x 8 (250ns) (5v)	8.95
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2732A-4	4096 x 8 (450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8 (250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8 (200ns) (5v) (21vPGM)	13.95
2764	8192 x 8 (450ns) (5v)	6.95
2764-250	8192 x 8 (250ns) (5v)	7.95
2764-200	8192 x 8 (200ns) (5v)	19.95
TMS2564	8192 x 8 (450ns) (5v)	14.95
MCM68764	8192 x 8 (450ns) (5v) (24 pin)	39.95
MCM68766	8192 x 8 (350ns) (5v) (24 pin)(pwr dn.)	42.95
27128	16384 x 8 (300ns) (5v)	29.95

5v = Single 5 Volt Supply 21vPGM = Program at 21 Volts

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

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- ★ Very competitive prices!
- ★ Friendly staff!
- ★ Fast service — most orders shipped within 24 hours!

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32.768 khz	1.95
1.0 mhz	3.95
1.8432	3.95
2.0	2.95
2.097152	2.95
2.4576	2.95
3.2768	2.95
3.579545	2.95
4.0	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
32.0	2.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

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BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

MISC.

UPD7201	29.95
TMS99532	29.95
ULN2003	2.49
3242	7.95
3341	4.95
MC3470	4.95
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11C90	13.95
95H90	7.95
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MM5369	3.95
MM5375	4.95
MM58167	12.95
MM58174	11.95
MSM5832	3.95

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AY5-3600	11.95
AY5-3600 PRO	11.95

CMOS

4000	.29	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4541	2.64
4009	.39	4543	1.19
4010	.45	4553	5.79
4011	.25	4555	.95
4012	.25	4556	.95
4013	.38	4581	1.95
4014	.79	4582	1.95
4015	.39	4584	.75
4016	.39	4585	.75
4017	.69	4702	12.95
4018	.79	74C00	.35
4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
4527	1.95	74C929	19.95

6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	9.95

DISC CONTROLLERS

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1791	24.95
1793	26.95
1795	29.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
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MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

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8035	5.95
8039	5.95
INS-8060	17.95
INS-8073	49.95
8080	3.95
8085	4.95
8085A-2	11.95
8086	24.95
8087	CALL
8088	29.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	29.95
8748	24.95
8755	24.95

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68B45	19.96
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	19.95
CRT5037	24.95
TMS9918A	39.95
DP8350	49.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	3.95
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	3.95
Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95

4.0 Mhz

Z80A-CPU	4.49
Z80A-CTC	4.95
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.49
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95

6.0 Mhz

Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	19.95
Z80B-SIO/2	39.95

ZILOG

Z6132	34.95
Z8671	39.95

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4LS03	.25	74LS181	2.15
4LS04	.24	74LS189	8.95
4LS05	.25	74LS190	.89
4LS08	.28	74LS191	.89
4LS09	.29	74LS192	.79
4LS10	.25	74LS193	.79
4LS11	.35	74LS194	.69
4LS12	.35	74LS195	.69
4LS13	.45	74LS196	.79
4LS14	.59	74LS197	.79
4LS15	.35	74LS221	.89
4LS20	.25	74LS240	.95
4LS21	.29	74LS241	.99
4LS22	.25	74LS242	.99
4LS26	.29	74LS243	.99
4LS27	.29	74LS244	1.29
4LS28	.35	74LS245	1.49
4LS30	.25	74LS247	.75
4LS32	.29	74LS248	.99
4LS33	.55	74LS249	.99
4LS37	.35	74LS251	.59
4LS38	.35	74LS253	.59
4LS40	.25	74LS257	.59
4LS42	.49	74LS258	.59
4LS47	.75	74LS259	2.75
4LS48	.75	74LS260	.59
4LS49	.75	74LS266	.55
4LS51	.25	74LS273	1.49
4LS54	.29	74LS275	3.35
4LS55	.29	74LS279	.49
4LS63	1.25	74LS280	1.98
4LS73	.39	74LS283	.69
4LS74	.35	74LS290	.89
4LS75	.39	74LS293	.89
4LS76	.39	74LS295	.99
4LS78	.49	74LS298	.89
4LS83	.60	74LS299	1.75
4LS85	.69	74LS323	3.50
4LS86	.39	74LS324	1.75
4LS90	.55	74LS352	1.29
4LS91	.89	74LS353	1.29
4LS92	.55	74LS363	1.35
4LS93	.55	74LS364	1.95
4LS95	.75	74LS365	.49
4LS96	.89	74LS366	.49
LS107	.39	74LS367	.45
LS109	.39	74LS368	.45
LS112	.39	74LS373	1.39
LS113	.39	74LS374	1.39
LS114	.39	74LS375	.95
LS122	.45	74LS377	1.39
LS123	.79	74LS378	1.18
LS124	2.90	74LS379	1.35
LS125	.49	74LS385	3.90
LS126	.49	74LS386	.45
LS132	.59	74LS390	1.19
LS133	.59	74LS393	1.19
LS136	.39	74LS395	1.19
LS137	.99	74LS399	1.49
LS138	.55	74LS424	2.95
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LS148	1.35	74LS640	2.20
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LS153	.55	74LS668	1.69
LS154	1.90	74LS669	1.89
LS155	.69	74LS670	1.49
LS156	.69	74LS674	14.95
LS157	.65	74LS682	3.20
LS158	.59	74LS683	3.20
LS160	.69	74LS684	3.20
LS161	.65	74LS685	3.20
LS162	.69	74LS688	2.40
LS163	.65	74LS689	3.20
LS164	.69	81LS95	1.49
LS165	.95	81LS96	1.49
LS166	1.95	81LS97	1.49
LS168	1.75	81LS98	1.49
LS169	1.75	25LS2521	2.80
LS170	1.49	25LS2569	4.25

74S00

74S00	.32	74S132	1.24	74S225	7.95
74S02	.35	74S133	.45	74S240	2.20
74S03	.35	74S134	.50	74S241	2.20
74S04	.35	74S135	.89	74S244	2.20
74S05	.35	74S138	.85	74S251	.95
74S08	.35	74S139	.85	74S253	.95
74S09	.40	74S140	.55	74S257	.95
74S10	.35	74S151	.95	74S258	.95
74S11	.35	74S153	.95	74S260	.79
74S15	.35	74S157	.95	74S273	2.45
74S20	.35	74S158	.95	74S274	19.95
74S22	.35	74S161	1.95	74S275	19.95
74S30	.35	74S162	1.95	74S280	1.95
74S32	.40	74S163	1.95	74S287	1.90
74S37	.88	74S168	3.95	74S288	1.90
74S38	.85	74S169	3.95	74S289	6.89
74S40	.35	74S174	.95	74S301	6.95
74S51	.35	74S175	.95	74S373	2.45
74S64	.40	74S181	3.95	74S374	2.45
74S65	.40	74S182	2.95	74S381	7.95
74S74	.50	74S188	1.95	74S387	1.95
74S85	1.99	74S189	6.95	74S412	2.98
74S86	.50	74S194	1.49	74S471	4.95
74S112	.50	74S195	1.49	74S472	4.95
74S113	.50	74S196	1.49	74S474	4.95
74S114	.55	74S197	1.49	74S482	15.25
74S124	2.75	74S201	6.95	74S570	2.95
				74S571	2.95

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78M05C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75	7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM323K	4.95
78H05K	9.95	UA78S40	1.95
78H12K	9.95		

C, T = TO-220   K = TO-3
L = TO-92

7400

7400	.19	74123	.49
7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

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8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
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DP8304	2.29
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XR 2240	3.25

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9000

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9401	9.95
9601	.75
9602	1.50
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LM301H	.79	LM348	.99	LM566	1.49	LM1800	2.37
LM307	.45	LM350K	4.95	LM567	.89	LM1812	8.25
LM308	.69	LM350T	4.60	NE570	3.95	LM1830	3.50
LM308H	1.15	LM358	.69	NE571	2.95	LM1871	5.49
LM309H	1.95	LM359	1.79	NE590	2.50	LM1872	5.49
LM309K	1.25	LM376	3.75	NE592	2.75	LM1877	3.25
LM310	1.75	LM377	1.95	LM709	.59	LM1889	1.95
LM311	.64	LM378	2.50	LM710	.75	LM1896	1.75
LM311H	.89	LM379	4.50	LM711	.79	ULN2003	2.49
LM312H	1.75	LM380	.89	LM723	.49	LM2877	2.05
LM317K	3.95	LM380N-8	1.10	LM723H	.55	LM2878	2.25
LM317T	1.19	LM381	1.60	LM733	.98	LM2900	.85
LM318	1.49	LM382	1.60	LM741	.35	LM2901	1.00
LM318H	1.59	LM383	1.95	LM741N-14	.35	LM3900	.59
LM319H	1.90	LM384	1.95	LM741H	.40	LM3905	1.25
LM319	1.25	LM386	.89	LM747	.69	LM3909	.98
LM320 (see 7900)		LM387	1.40	LM748	.59	LM3911	2.25
LM322	1.65	LM389	1.35	LM1014	1.19	LM3914	3.95
LM323K	4.95	LM390	1.95	LM1303	1.95	LM3915	3.95
LM324	.59	LM392	.69	LM1310	1.49	LM3916	3.95
LM329	.65	LM393	1.29	MC1330	1.69	MC4024	3.95
LM331	3.95	LM394H	4.60	MC1349	1.89	MC4044	4.50
LM334	1.19	LM399H	5.00	MC1350	1.19	RC4136	1.25
LM335	1.40	NE531	2.95	MC1358	1.69	RC4151	3.95
LM336	1.75	NE555	.34	MC1372	6.95	LM4250	1.75
LM337K	3.95	NE556	.65	LM1414	1.59	LM4500	3.25
LM337T	1.95	NE558	1.50	LM1458	.59	RC4558	.69
LM338K	6.95	NE561	24.95	LM1488	.69	LM13080	1.29
LM339	.99	NE564	2.95	LM1489	.69	LM13600	1.49
				LM1496	.85	LM13700	1.49

H = TO-5 CAN   T = TO-220   K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

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2716 16K EPROMS $\$3^{95}$ EA   4116 250 NS $8/\$7^{95}$

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- ★ PRESET TO CHANNEL 3
- ★ USE TO BUILD TV-COMPUTER INTERFACE
- ★ +5 VOLT OPERATION

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IDEAL FOR HOBBYIST, BENCHWORK & DO-IT-YOURSELFERS! 90-DAY WARRANTY! NEW & UNUSED! QUANTITIES LIMITED!

ASTEC AA11190

- ★ QUAD OUTPUT SWITCHING DESIGN AS USED IN APPLE III
- ★ +5 @ 4A; -5 @ .25A
- ★ +12 @ 2.5A; -12 @ .30A; 15.5"x4.5"x2"

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Model 2PC2241

- ★ DESIGNED FOR DEC EQUIPMENT
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- ★ AUXILIARY AC OUTLET
- ★ +5 @ 4A; -15V @ 1.5A; 12.25"x4"x4.75"

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& BOUGHT TOO MANY OF THESE GEMS!

4116 250NS 8/7.95

DYNAMIC RAM MM5298 8K x 1 ... .95

CAPACITORS

TANTALUM

	6V	10V	15V	20V	25V	35V
.22uf						.40
.27						.40
.33						.40
.47				.35		.50
.68						.45
1.0			.40	.40	.45	.45
1.5				.45		.50
1.8						.75
2.2		.35	.40	.45		.65
2.7		.40	.45			.90
3.3		.45	.50	.55	.60	.65
3.9		.45				
4.7	.45	.55		.60	.65	.85
6.8			.70		.75	
8.2						1.00
10	.55	.65	.80	.85	.90	1.00
12	.65		.85	.90		
15	.75	.85	.90			
18			1.25			
22		1.00	1.35			
27			2.25			
39		1.50				
47	1.35					
56	1.75					
100		3.25				
270	3.75					

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

MONOLITHIC

.1uf-mono	50V	.18	.47uf-mono	50V	.25
.047uf-mono	50V	.15	.01uf-mono	50V	.14

ELECTROLYTIC

RADIAL			AXIAL		
.47uf	50V	.14	1uf	50V	.14
1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
4.7	50V	.15	10	50V	.16
10	50V	.15	22	16V	.14
47	35V	.18	47	50V	.20
100	16V	.18	100	15V	.20
220	35V	.20	100	35V	.25
470	25V	.30	150	25V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			500	16V	.42
			1000	16V	.60
			1500	16V	.70
			5000	16V	.85

COMPUTER GRADE

26,000uf 30V 3.95

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

DIODES

1N751	5.1 volt zener	.25
1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55
VM48	Dip-Bridge	.35

NEW UN-USED MUFFIN FANS

4.68" Square	14.95
3.125" Square	14.95

HEAT SINKS

TO-3 style	.95
TO-220 style	.35

SWITCHES

SPDT mini-toggle	1.25
DPDT mini-toggle	1.50
SPST mini-pushbutton	.39

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TRANSISTORS

2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.75	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

BYPASS CAPS

.01 UF DISC	100/6.00
.01 UF MONOLITHIC	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

LED LAMPS

	1-99	100-up
JUMBO RED	.10	.09
JUMBO GREEN	.18	.15
JUMBO YELLOW	.18	.15
LED MOUNTING HARDWARE	.10	.09

LED DISPLAYS

HP 5082-7760	.43"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49
TIL-311 4x7	.270"	HEX W/LOGIC	9.95

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	5.95	call
24 pin ZIF	7.95	call
28 pin ZIF	8.95	call
ZIF = TEXTOOL (Zero Insertion Force)		

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

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TERMS: Minimum order $10. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges — please contact our sales department for the amount. CA residents must include 6% sales tax, Bay Area and LA residents include 6½%. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

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Circle 203 on inquiry card.

2732 32K EPROM $4.95 | 2764 64K EPROM $6.95

MICROCOMPUTER HARDWARE HANDBOOK

FROM ELCOMP — $14.95

Over 800 pages of manufacturers data sheets on most commonly used IC's.

Includes:

- ★ TTL — 74/74LS and 74F
- ★ CMOS
- ★ Voltage Regulators
- ★ Memory — RAM, ROM, EPROM
- ★ CPU's — 6800, 6500, Z80, 8080, 8085, 8086/8
- ★ MPU support & interface — 6800, 6500, Z80, 8200, etc.

DISK DRIVES

TANDON

TM100-1	5¼" (FOR IBM) **SS/DD**	**229.00**
TM100-2	5¼" (FOR IBM) **DS/DD**	**259.00**

SHUGART

SA 400L	5¼" (40 TRACK) **SS/DD**	**199.95**
SA 400	5¼" (35 TRACK) **SS/DD**	**189.95**

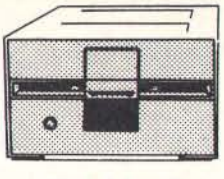
PERTEC

FD-200	5¼" **SS/DD**	**179.95**
FD-250	5¼" **DS/DD**	**199.95**

MPI

MP-52	5¼" (FOR IBM) **DS/DD'**	**249.00**

NOTE: Please include sufficient amount for shipping on above items.



8-INCH DISK DRIVE SALE

FD 100-8
SHUGART 801 EQUIV.
SS/DD — 10/$175 EA.
$189.00

FD 200-8
SHUGART 851 EQUIV.
DS/DD — 10/$220 EA.
$239.00

BEST SELLING BOOKS

OSBORNE/MC GRAW-HILL

Apple II User's Guide	16.95
CRT Controller's Handbook	9.95
68000 Assembly Language Programming	16.99
CBASIC User Guide	15.00

SYBEX

Your First Computer	8.95
The CP/M Handbook	14.95
The PASCAL Handbook	18.95
Microprocessor Interfacing Techniques	17.95

EDGE-CARD CONNECTORS

S-100 ST	**3.95**
S-100 WW	**4.95**
72 pin ST	**6.95**
72 pin WW	**7.95**
50 pin ST	**4.95**
44 pin ST	**2.95**
44 pin WW	**4.95**

CABINETS FOR 5¼" DISK DRIVES

CABINET #1 $29.95

- ★ DIMENSIONS 8⅝ x 5 15/16 x 3 15/16"
- ★ COLOR MATCHES APPLE
- ★ FITS STANDARD 5¼" DRIVES, INCL. SHUGART
- ★ INCLUDES MOUNTING HARDWARE AND FEET

NOTE: Please include sufficient amount for shipping on above items.

CABINET #2 $79.00

- ★ COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
- ★ DIMENSIONS: 11½ x 5¾ x 3 15/16"
- ★ +5V @ 1 AMP, +12V @ 1.5 AMP
- ★ FITS STANDARD 5¼" DRIVES
- ★ PLEASE **SPECIFY** GRAY OR TAN

TRANSFORMERS

FRAME STYLE

12.6VAC	**2amp**	**4.95**
12.6VAC CT	**2amp**	**5.95**
12.6VAC CT	**4amp**	**7.95**
12.6VAC CT	**8amp**	**10.95**
25.2VAC CT	**2amp**	**7.95**

PLUG CASE STYLE

12VAC	**250ma**	**3.95**
12VAC	**500ma**	**4.95**
12VAC	**1amp**	**5.95**
12VAC	**2amp**	**6.95**

DC ADAPATER

6, 9, 12 VDC selectable with universal adapter	**8.95**

NOTE: Please include sufficient amount for shipping on above items.

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CENTRONICS

IDCEN36	**Ribbon Cable**	**36 Pin Male**	**8.95**
IDCEN36/F	**Ribbon Cable**	**36 Pin Female**	**8.95**
CEN36	**Solder Cup**	**36 Pin Male**	**7.95**

DIP CONNECTORS

DESCRIPTION	HIGH RELIABILITY TOOLED ST IC SOCKETS	COMPONENT CARRIERS (DIP HEADERS)	RIBBON CABLE DIP PLUGS (IDC)
ORDER BY	AUGAT**xx**-ST	ICC**xx**	IDP**xx**
CONTACTS 8	.99	.65	
14	.99	.75	1.45
16	.99	.85	1.65
18	1.69	1.00	
20	1.89	1.25	
22	1.89	1.25	
24	1.99	1.35	2.50
28	2.49	1.50	
40	2.99	2.10	4.15

For order instructions see "IDC Connectors" below.

RIBBON CABLE

CONTACTS	SINGLE COLOR		COLOR CODED	
	1'	10'	1'	10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP		RIGHT ANGLE PC SOLDER		IDC RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DB**xx**P	DB**xx**S	DB**xx**PR	DB**xx**SR	IDB**xx**P	IDB**xx**S	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

MOUNTING HARDWARE 1.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDH**xx**S	IDH**xx**SR	IDH**xx**W	IDH**xx**WR	IDS**xx**	IDM**xx**	IDE**xx**
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

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FOR APPLE COMPUTER USERS

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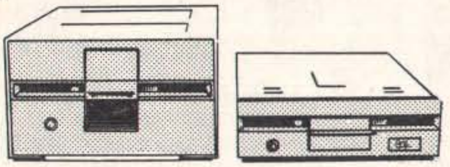

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JDR HALF-HEIGHT DISK DRIVE $\$239^{95}$
- 35 Track w/Apple Controller
- 40 Track Controller and DOS Available (Call for Price)

JDR 16K RAM CARD FOR APPLE II+ $\$44^{95}$
- 2 YEAR WARRANTY

Kit with Instructions	$40.95
Bare PC Card	$14.95

JDR COOLING FAN CLEARANCE SALE! $\$49^{95}$
- With Surge Protection
- Quantities Are Limited!

OTHER ACCESSORIES FOR APPLE II

THUNDERCLOCK $129.95
- Real-Time Clock Calendar ★ Software Included
- Mountain Software Compatible
- BSR Control Options Available

KRAFT JOYSTICK $39.95

micromax MANIA

VIEWMAX-80 NOW ONLY $\$159^{95}$
- 80 Column Card for Apple II+
- Video Soft Switch
- Inverse Video ★ 2 Year Warranty

VIEWMAX-80e ....NEW $\$129^{95}$
- 80 Column Card for Apple IIe
- 64K RAM Expandable to 128K

64K RAM Upgrade $47.60

GRAPHMAX................. $\$129^{95}$
- Hi Resolution Graphics
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Graphmax with Color & Zoom Options $149.95

MA SYSTEMS

FD-35 DISK DRIVE $229.95
- Shugart Mechanism — Made in U.S.A.
- Direct Replacement for Apple Disk II ★ 1 Year Warranty

CONTROLLER CARD $69.95
- One Year Warranty

APPLE COMPATIBLE POWER SUPPLY

$\$79^{95}$
- Use To Power Apple-Type Systems
- +5V @ 5A +12V @ 3A -5V @ .5A -12V @ .5A
- Instructions Included

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FEDERAL EXPRESS SERVICES AVAILABLE

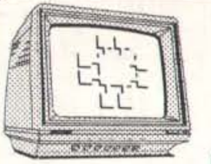
PERISOFT

PRINTERLINK $\$59^{00}$
- Low Cost Centronics Parallel Interface with Cable and Manual

MESSENGER $\$99^{00}$
- Serial Interface Connects Virtually Any Serial Device
- Includes Cable

TIMELINK $\$84^{00}$
- Real-Time Clock Calendar with Alarm Feature

ALL WITH ONE YEAR WARRANTY



MONITORS

MONOCHROME

BMC BM 12AUW GREEN 12" NEW	$89.95
BMC BM 12AUY 18 MHZ AMBER	$139.95
NEC JB1201M - 20 MHZ GREEN	$169.00
ZENITH ZVM-121 - 15 MHZ GREEN............	$99.00

COLOR

BMC BM-AU9191U COMPOSITE 13"	$279.00
AMDEK COLOR I - COMPOSITE	$335.00

NO C.O.D. ORDERS PLEASE

VERBATIM DATALIFE DISKETTES

SS/DD SOFT SECTOR	29.95
SS/DD 10 SECTOR HARD	29.95

NASHUA DISKETTES

5¼" WITH HUB RING	
MD1 SOFT SECTOR, SS/SD	19.95
MD1D SOFT SECTOR, SS/DD	26.25
MD2D SOFT SECTOR, DS/DD	30.75
MD2F SOFT SECTOR, DS/QUAD DENSITY	45.00
MD110 10 SECTOR HARD, SS/SD	19.95
MD210D 10 SECTOR HARD, DS/DD	30.75
8" WITHOUT HUB RING	
FD1 SOFT SECTOR; SS/SD	24.75
FD1D SOFT SECTOR, SS/DD	30.00
FD2D SOFT SECTOR, DS/DD	36.75

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Unclassified Ads

WANTED: Information, documentation, and peripherals for Altair 8800b manufactured by MITS to be used in a vocational-electronics class. K. Luhrs, Education Department, California Rehabilitation Center, POB 1841, Norco, CA 91760.

WANTED: Hospital wishes to purchase or welcomes donation of one or more Tektronix 4051 computers. Dr. Peter Hulick, Lynchburg General Hospital, Lynchburg, VA 24506.

WANTED: If you need answers to any questions concerning CP/M, Pascal, C language, programming techniques, computer and software selection criteria, or related topics, ask me. I will locate the answers to your questions. Send SASE. Bhavisyat, RD 1, Box 331, Moundsville, WV 26041.

WANTED: Unitarian-Universalist churches need used computing equipment, or unused manufacturer's over-runs or out-dated units. Have immediate requirements for DEC-compatible LQ Printer, two Atari-compatible disk drives, and two Atari-compatible printers. All tax-deductible. Also, willing to exchange information and equipment. Unitarian Universalist Computer Interchange, c/o D. P. Lantz, 1373 Howell Dr., Newark, OH 43055, (614) 344-6600.

FOR TRADE: I am interested in exchanging software with Commodore 64 users. Send a full list of all your software, plus a SASE for my list. ICCC, Kim Moser, 127 East 15th St., New York, NY 10003.

WANTED: We would like to exchange ideas, suggestions, and information regarding software and hardware with other Epson QX-10 owners from anywhere and everywhere. Bruce and Lynn Holloway, 8 Tri City Rd. Apt. 10, Dover, NH 03820.

WANTED: Information on licensing, copyrighting, or protecting software to insure the buyer agrees not to change the software. V.E.H., 914 North Court, Rockford, IL 61103.

WANTED: People with knowledge of sequential text files of Apple II Plus and TRS-80 Models II and III. Possible formation of a computer club (I have an Apple II Plus 64K and access to TRS-80s). Also, information on procedures for on and off of Reset and CTRL-C keys; knowledge and/or advice for selling software and/or forming a software company; Applesoft 3.3 BASIC Compilers and offers too. Will trade Apple game programs and utilities. George R. Lewycky, 7 Durst Dr., Milltown, NJ 08850.

WANTED: Last updated version of Heath tape O.S. and use of Phi-Decks with Heath cassette board. C.T. Huth, 146 Schonhardt St., Tiffin, OH 44883.

WANTED: Information and/or correspondence with users of Timex/Sinclair computers about clubs, programs, books, modems, software, and hardware. I will also trade cassette programs. Greg C. Backman, Naval Base Seattle, 7500 Sand Point Way NE, Seattle, WA 98115.

FOR SALE: Apple II 48K Applesoft in ROM with Applesoft and reference manuals; 2½ years old: $890. Disk II with the DOS 3.3 manual: $295. Disk II controller card: $60. All in good condition: $1200. All U.S. funds. I will pay shipping. Louis Roy, 2590 4th Ave., St-Georges Ouest, Cte Beauce, Quebec G5Y 3S8, Canada.

FOR SALE: HP-41C system: HP-41C, asking $167/was $250; Quad RAM, $63/$95; Two each RAM, $20/$60; PPC ROM with manuals, $200/$95; circuit-analysis ROM, $20/$30; card reader, $143/$215; bar-code reader, $83/$125; homebrew I/O breakout, $10/$30; three 3-inch binders of software and information, $80/$120. Everything above: asking $500/was $1020, shipping included. Jan Steinman, 4622 North 3rd St., Arlington, VA 22203, (703) 524-7560.

TO TRADE: I would like to swap Apple II programs: games, utilities, and business. Send me a list of your programs and I will send you mine. Also looking for people interested in corresponding. Matthias Pohl, Heidelbergerstr 33,6901 Mauer, West Germany.

WANTED: High school student and future hacker would appreciate any kind of electronic junk or broken equipment you could send. I will pay shipment. Ricardo Correa K., Metsakorventie 6.A.4, 08500 Lohja as., Finland.

FOR TRADE: I would like to swap IBM PC software. Need graphics, games, utilities, financial, education, and home programs. Have many French programs. Send SS disk for one of mine. D. Coulombe, Box 1283 Notre-Dame, Levis, Quebec G6W 6A8, Canada.

WANTED: Reset key cover for Apple II keyboard to prevent Reset accidents when reaching for the Return key, or name of a supplier. Paul Connolly, 389 Courtland Ave., Stamford, CT 06906, (203) 327-3318.

FOR SALE: Shugart SA400: $125. BASF 6106 SSDD: $160. S-100 8K static RAM board: $35. M6800 S-100 board: $50. Datamedia 1521A video terminal: $300 ($1100 new). All currently in use, like new, with full documentation, UPS prepaid. Inquire about back issues of BYTE. Robert Boyd, Woodlawn Ave., Box 1044, Kennebunkport, ME 04046.

FOR SALE: HP 608D Signal Generator 10-420 MHz spare tubes, works: $325. Dual Siemens FDD-100-5 5¼-inch drives with power supply and signal cable: $400. New TI-59 calculator, hardly used: $125. K. W. Humbard, Cape Lisburne AFS AK, APO Seattle, WA 98716, (907) 725-1237.

WANTED: Computer pen pals who want to connect with others via a modem, send your name, address, phone number, time you're available, and interests (programming or games, etc.) to Computer Pals, c/o Steve Smith, POB 27533, Atlanta, GA 30327.

FOR SALE: TRS-80 Model I, Level II with 16K and lowercase hardware installed: $250. Also, Radio Shack Line Printer II with interface cable for TRS-80: $300. Keith Wishart, Rt. 2 Box 13, Mapleton, MN 56065, (507) 524-3921.

FOR SALE: Radio Shack Quick Printer II with manual and cables for connection to Model I CPU and expansion interface. Perfect condition: $100. Michael Friedman, 495 East 18 St., Brooklyn, NY 11226, (212) 282-4029.

WANTED: High school student with an interest in computers is looking for donations of equipment or manuals in any condition. Will try to cover shipping costs. Scott Fahey, 7 Boundary Circle, Brockton, MA 02402, (617) 588-4444.

WANTED: For Texas Instruments TI 99/4A: peripherals expansion system, modem, drives, RS-232C interface card, P-code card, or any other TI hardware or software. Wayne M. DeMello, 26 Norwell St., South Dartmouth, MA 02748, (617) 994-7885.

WANTED: Target game for SOL computer wanted, including any information or source code (300 bps tape). Need information on tape format. Also, Tarbell cassette interface for $25 or less. Michael Dunn, 45 Livingston Rd. #501, West Hill, Ontario M1E 1K8, Canada, (416) 266-1635.

FOR SALE: Radio Shack Line Printer II (same as Centronics #730-I) with parallel interface for 9½-inch fixed-pinfeed or up to 8½-inch cut-sheet or roll paper; excellent condition, with dust cover, one ribbon, and manual. Will include cable for TRS-80 Model III and/or a homemade interface for direct connection to TRS-80 Model I keyboard, if desired. Shipped prepaid in U.S. on receipt of certified check: $350, offers considered. David Shinn, 28 Wagon Bridge Run, Moorestown, NJ 08057.

FOR SALE: Public domain software for VIC-20 and CBM-64. Many useful games, utilities, and more. Includes complete documentation. Program-Pac with 10 CBM-64 programs: $5. Ten programs on tape for VIC-20: $5. Add $1 for shipping. Prepaid; check or money order. Also, inquire about user group forming. J. Jesrani, 1052 Southeast 54th Ave., Ocala, FL 32671.

FOR SALE: Apple II Plus 48K without disk or monitor. Two years old, in perfect condition. Includes serial interface and 10 games on cassette: $900. Mike Underwood, 11122 Fairhaven Ct. Apt E, Fairfax, VA 22030, (703) 352-0180.

FOR SALE: Two OSI C3B four-user systems. Both feature 200K static RAM, dual 8-inch floppy disks, and 80M Winchester disk. One system features one Centronics printer port and three RS-232 ports. The other features one Centronics printer port and one RS-232 port. Includes manuals, timeshare software, some customs software, and assorted goodies: $13,000 each or prices negotiable. Rapid Die & Molding, 800 East Amelia, Cassville, WI 53806, (608) 725-5114 (ask for Barry).

FOR SALE: TRS-80 Model I 48K two Percom drives, lowercase conversion, Percom double-density board, RS-232, cassette, Quick Printer II, and all dust covers. All cables and many programs included. $1700; I'll ship. Rick Thompson, 1212 El Camino Reale, Socorro, NM 87801.

FOR SALE: Ithaca Intersystems DPS-1 computer includes mainframe, front panel, Series II processor board, MIO board with two parallel and two serial ports, vectored interrupts, FDC-2 DMA disk controller, 64K of 8-/16-bit memory. Also, a Heath H-19 terminal, and 8-inch double-density disk with power supply and cabinet. Software includes Pascal-Z, CP/M, relocatable macro assembler, and m-bug. New $5200, sell $2500. Keith Pattison, 9629 Bradhugh Ct., Sacramento, CA 95827, (916) 361-3648.

FOR SALE: Commodore 64: $275. Gemini printer with interface for Commodore: $450. Dennis Hallingstad, (608) 269-2392.

FOR SALE: BYTE Vol. 1 No. 12 and all issues of Vol. 2, 3, 4, 5, 6, and Vol. 7, No. 9; (inclusive, 68 consecutive issues). Best offer for all. W. J. Holland, 2675 Gulf of Mexico, Longboat Key, FL 33548.

FOR SALE: 12-inch RGB color monitor, Taxan RGB I; like new, only used several hours. Compatible with Apple II, Apple III, IBM and others: $295 or best offer. David Klotzbach, 25 Columbia Circle, Plymouth, MA 02360, (617) 747-0430.

WANTED: Collections of software, programs, books, manuals, or magazines to buy pertaining to Atari 400/800. Stephanie Ring, Star Route Box 132, Staples, MN 56479, (218) 587-2838.

FOR SALE: Hewlett-Packard HP-41C calculator, card reader, quad RAM: $225. Also, bar-code wand, timer module, extended function, extended memory modules, AME port extender, and HHC 16K EPROM box. Also, wanted: Commodore 2031 single disk drive in good condition. John E. Barnes, 13 Alcott Dr., Wilmington, DE 19808, (302) 453-3622 days, 994-7831 evenings.

FOR SALE: Powertext Word Processing System by Beaman Porter Inc., Apple III, version 1.61, brand new: $100 or best offer H. R. Flores, 113 Fairmont Ave., Worcester, MA 01604, (617) 756-2980.

FOR SALE: Okidata 84A printer with 200 cps, near letter-quality, high-resolution (144 by 144 dots per inch) graphics, downloadable character set, full software control. Also, free PROMs from manufacturer for future enhancements, parallel interface, friction/tractor feed, perfect condition: $700. 2K serial board: $75. Or both: $750. Make an offer. D. B. Phuoc, Box 4403, Hayward, CA 94540, (408) 970-3832.

FOR SALE: BYTE, all issues from 1976 thru 1979. Make offer. G. March, 2110 Country Club Pkwy. SE, Cedar Rapids, IA 52403, (319) 364-0092.

FOR SALE: Novation 212 auto-cat modem. Brand new condition, asking $500. Arnold Slavin, 655 Union Blvd., Totowa, NJ 07511, (201) 256-2300.

WANTED: College student would appreciate a donated computer for experiments. Vatche Terzian, 2421 Foothill Blvd. #22B, La Verne, CA 91750.

WANTED: SOL-20 systems manual, sections III and IX and Solos operating system manual. I will pay for duplication and postage. Jeff Henkels, 1312 Birch, Ames, IA 50013, (515) 294-7298.

WANTED: I have a BASIC-E compiler and interpreter; I need a users manual or other documentation for BASIC-E language. Will buy, rent, or borrow. Wm. F. Fowler, 4014 Hillwood Court, Beltsville, MD 20705.

FOR SALE: New Xerox 820 CPU module with printer port, communications port, and disk interface. ADDS Regent 40 terminal with printer port and manuals. Diablo 1650 38-cps daisy-wheel letter-quality printer with manual, RS-232C serial interface, and 1200 bps. Debbie Pullinger, 208-D Stephen Ave., Mary Esther, FL 32569, (904) 581-3319 after 5 p.m. CT.

FOR SALE: NEC 8001A computer, new condition: $375. Bob Quint, 4378 Gina St., Fremont, CA 94536, (415) 657-7385.

WANTED: Used, serviceable, Xerox 88 character, metalized (9R21100 series) printwheels with over twenty typestyles. Which typestyles do you have? Bob Greenawalt, 9239 De Adalena St., Rosemead, CA 91770, (213) 572-0419 evenings.

FOR SALE: BYTE, first 16 issues, good condition, best offer. Edw. L. Hayden, 16 Decatur Ave., Annapolis, MD 21403, (301) 267-6098.

WANTED: Apple II user interested in parameters needed to back up protected software using current copy programs such as Locksmith, Nibbles Away, etc. I am compiling a master list of parameters. Those who contribute may receive a copy. Philip McDermott, 1500 Aubudon Parkway, Louisville, KY 40213, (502) 635-7867.

WANTED: Hewlett-Packard HP-IL digital cassette drive, HP-IL interface module, and HP-IL printer/plotter (HP 821 2A) all for HP-41CV. Must be in good condition, reasonably priced. M. C. Akisoglu, 120 Canterbury Lane, McMurray, PA 15317, (412) 237-2690.

FOR SALE: Software (in English and Spanish) for engineering, statistical analysis, process-control applications, as well as games and useful word processors for the VIC-20 (4K RAM, 22 column). José G. V. Humérez, casilla 525, Sucre, Bolivia, South America.

WANTED: To trade Visicalc and PFS File & Report programs for Apple III and to swap for same for use on Apple II Plus. Also, other programs to swap. Let's trade lists. G. M. Koellisch, 106 Reno Dr., Louisville, OH 44641.

FOR SALE: Heath H-8 computer, 32K RAM, serial/cassette interface board, extender board, Heath H-9 video terminal. Software: BUG-8, TED-8, HASL-8, Extended Benton Harbor BASIC. All schematics, assembly, and operation manuals. Also, EC-1100 BASIC programming course and EC-1108 Assembly Lanugage course. Radio Shack CTR-41 cassette player. REmark magazine, all issues. Bill Ward, 3621 Lowden, Kalamazoo, MI 49008, (616) 345-2844.

FOR SALE: Several programs and games for Victor 9000 available in MS-DOS. dBASE II, Wordstar/Mailmerge/Spelling, Mutliplan, Report Manager (Victorcalc), Programmers Tool Kit, Graphics Tool Kit, BASIC Compiler, Pascal, and FORTRAN: $100 to $200. Bruce Glenn, Image Equipment, 90 Park Ave., New York, NY 10016, (212) 697-8606.

FOR SALE: Two disk drives, Tandem TM100-1, 5¼-inch (for IBM), SS/DD drive, no power supply or case: $170 each. Jim Lovewell, 1490 East Juana, San Leandro, CA 94577, (415) 351-6207.

UNCLASSIFIED POLICY: Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial (individuals or bona fide computer clubs only), typed double-spaced on plain white paper, contain 75 words or fewer, and include complete name and address. This service is free of charge; notices are printed once only as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least three months for your ad to appear. Send your notices to Unclassified Ads, BYTE/McGraw-Hill, POB 372, Hancock, NH 03449.

Unclassified Ads

FOR SALE: An unused Apple II Language Card: $130 or best offer. K. Sung, 0-11 Pine Grove, Ypsilanti, MI 48197, (313) 483-7998.

WANTED: Professional software for the dimensioning of heat-plate exchangers when given the desired temperature sanitary warm water can supply, the needed temperature of the primary circuit, the dimensions and number of the plates, and the thermic coefficient of the exchanger. Also, software for chemical balance needed for ideal swimming pool-water conditions. M. Riccieio, Lloyd & Limaro SA, Rue Dufour 34, CH-2500 Bienne 3, Switzerland; tel: (032) 42 43 66; Telex: 349 475.

WANTED: Apple software to trade. Send a list and SASE of your games or utilities software and I will send you mine. Ralph Boswell, 8 George Washington Dr., Titusville, NJ 08560.

FOR SALE: Wintek System, 32K RAM, refresh card, two serial and two parallel ports. Monitor in ROM, cassette interface at 300 to 2400 bps. BASIC in ROM, 8K open ROM slots. 8-slot motherboard, power supply. Wintek terminal, Setchell-Carlson monitor, modem, TSC cassette BASIC (extended), TSC Relocator, Wintek Editor/Assembler, and more: $1350. February '80 through January '83 68000 Micro Journal. Make an offer. John Adams, 8303 Kenwood Rd., Cincinnati, OH 45236, (513) 793-2338.

WANTED: If you're building a digital synthesizer (like I am) or if you want to share ideas, let's start DSIG, Digital Synthesis Information Group. Shane Bouslough, Pond View Rd., RR2, Wading River, NY 11792, (516) 929-6436.

WANTED: S-100 components. IMSAI or Cromemco mainframe, Cromemco TUART, 16FDC, ZPU, 64KZ Rev J, CCS 2066 RAM. Possibly interested in S-100 hard disk, 9-track 1600 BPI tape, and I/O boards. Gary Sanford, POB 1689, Lowell, MA 01853, (617) 263-2389 evenings.

FOR SALE: DEC LSI 11 homebrew system. KD 11 CPU with EIS/FIS, DLV 11, 64K-bytes RAM, Unibus adapter, RK 11 disk interface with Diablo 33 disk drive. Also, second Diablo drive and all power supplies. Will run BASIC and FORTRAN under RT 11: $2000 or best offer. David Barr, 37 Ruthven Place, Summit, NJ 07901, (201) 582-3227 days.

FOR SALE: Texas Instruments 742 intelligent terminal with a Silent 700 ASR terminal, 80-column thermal printer, two built-in digital-cassette tape drives under full program control, 2K of programmable RAM, a built-in 1200-bps modem (requires a DAA phone company interface), and two serial RS-232C interfaces. Also, Assembler, mini Word Processor, utilities, manuals, digital-cassette tapes, and supplies included: $500. Neal Fahrer, 5909 Blairstone Dr., Culver City, CA 90230, (213) 836-8615.

WANTED: Zorba owners who would like to start (or join) a user's group for Telcon's Zorba to explore its potential by exchanging information, ideas, advice, software, and a newsletter. Jeffrey Timm, 6-J Aspinwood Way, Baltimore, MD 21237.

FOR SALE: Burroughs L5000 accounting machine in excellent condition. Printer has 25-inch carriage with 250 print positions and three feeds: one friction and two pin. Full alpha and numeric keyboards with 24 auxiliary subroutine keys. Built-in hard disk and paper-tape reader. Would consider trade for mini computer system or ?? David A. Livsey, POB 990, Escondido, CA 92025.

WANTED: Names and addresses of Superbrain users groups around the country that I may correspond with or join. Also interested in CP/M users groups using 5¼-inch disk formats. Want to sell: printer cable for Atari 850 interface to standard 36-pin parallel-printer port. Reasonable. L. David Paquette, 14 North Ridge, Ballston Lake, NY 12019, (518) 899-6376.

FOR SALE: New and used S-100 boards. Z80-based CPU boards with serial port and parallel port: $120. 8K static RAM boards: $40. Input/output boards with three serial and two parallel ports: $95. L. Cobbledick, 192 River Valley Dr., Chesterfield, MO 63017, (314) 576-0957 nights or 569-2660 days.

FOR SALE: Memorex 5440 disk cartridges for Diablo series 40 disk drives or CDC Hawk disk drives. $15 each or will trade. Blane Woodard, 4942 North Diversey, Whitefish Bay, WI 53217, (414) 963-1423 evenings.

WANTED: High school student/programmer seeking correspondence with owners of TRS-80 Color Computers to exchange programs and information. Glen Button, POB 536, Cheshire, CT 06410.

FOR TRADE: Large library of Apple software to trade. Send me a list with SASE of your programs and I'll send you mine. Wayne Reibold, 205 North Loraine Ave., Glendora, CA 91740.

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A Popular Preview

The Product Preview of Hewlett-Packard's HP 150 proved to be the most popular article in BYTE's October issue. Staffers Phil Lemmons and Barbara Robertson will have to forfeit the $100 prize. For his User's Column, "New Computers, Boards, Languages, and Other Tidbits," Dr. Pournelle won the $50 prize. For third place, readers selected "An Interview: The HP 150's Design-team Leaders," also written by the authors of October's winning Product Preview. In fourth place is "The Unix Tutorial, Part 3: Unix in the Microcomputer Marketplace," written by David Fiedler. And Steve Ciarcia won fifth place with the second part of his Circuit Cellar project entitled "Build the Micro D-Cam Solid State Video Camera, Part 2: Computer Interfaces and Control Software." Congratulations to these authors.

Correspondence

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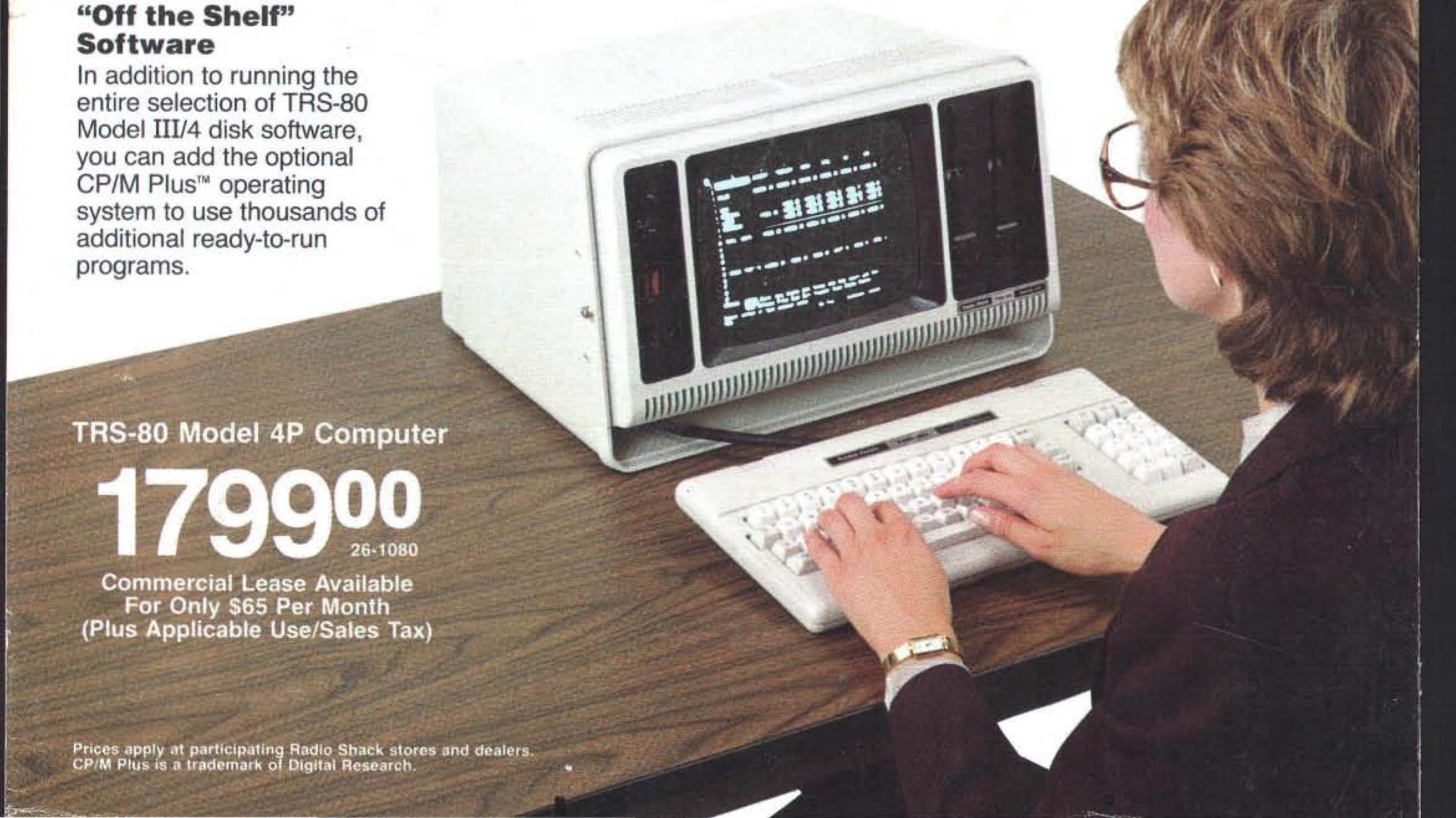

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